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ELECTRONIC COMPUTER PROGRAMMING INSTITUTE

I·B·M Data Processing and Computer Programming Course

STUDY UNIT V

LESSON 13 - 14 - 15

I.B.M. DATA PROCESSING AND COMPUTER PROGRAMMING

LESSON #13

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Glossary

Examination

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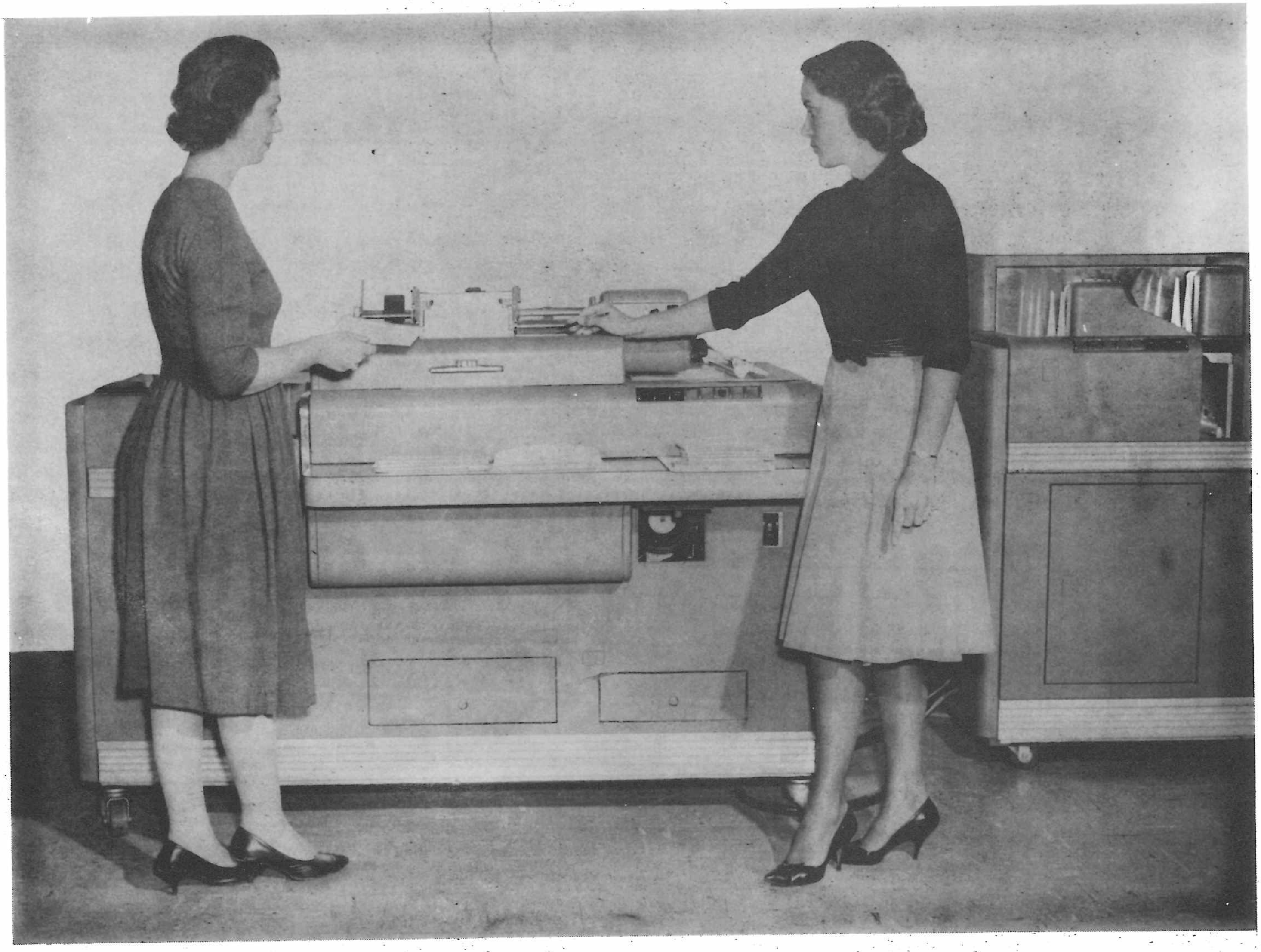
PREFACE

The next six lessons will be devoted to the study of the I. B. M. type 402 accounting machine (also called a tabulating machine.) The machines discussed in previous lessons are used generally to create or prepare data for processing through the tabulator. The tabulator is the machine which will give us our final reports and statistics prepared in printed form. This machine can add and subtract, assemble and select data and print in a variety of formats. A photograph of the 402 is shown below.



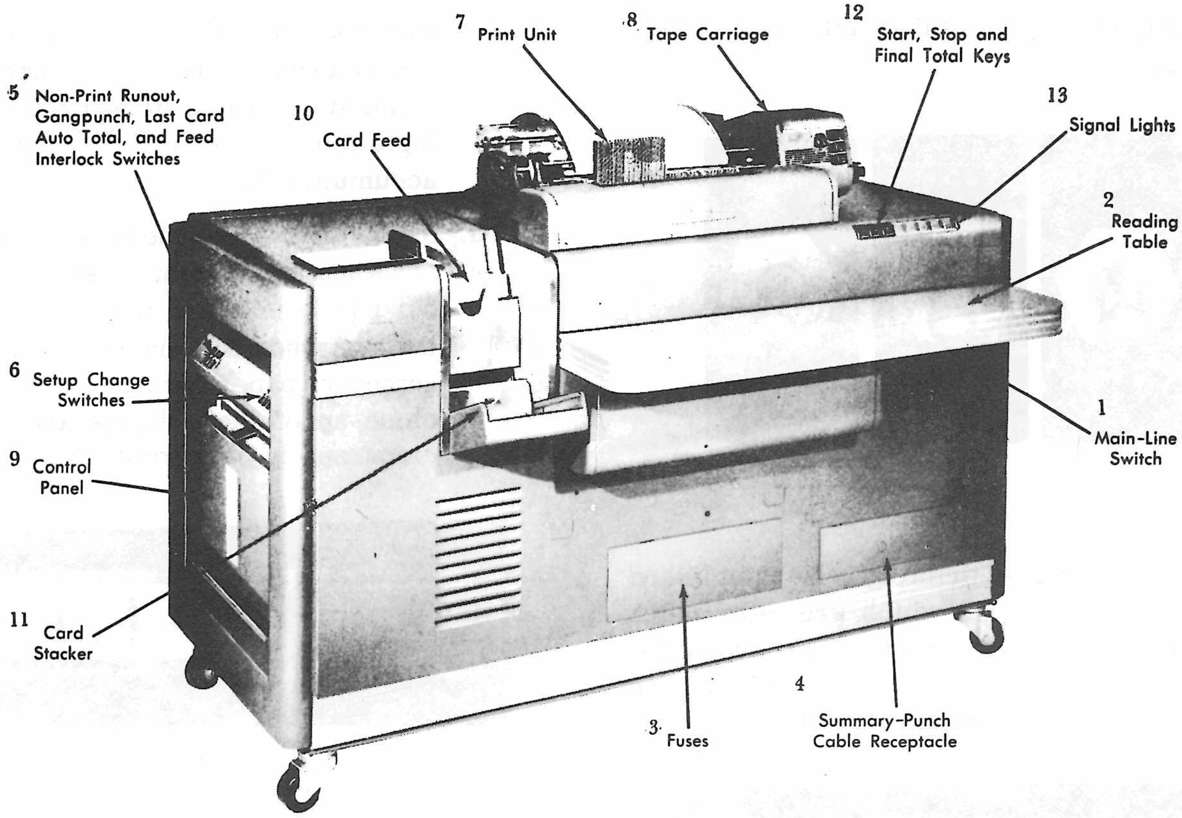


Figure 1. The 402 tabulating machine.

13.1 OPERATING CHARACTERISTICS OF THE 402

Figure 1 illustrates the 402 tabulating machine with the operating features numbered. Let us briefly discuss them.

1. Main-Line Switch - turning this switch on supplies electrical current to the machine.
2. Reading Table — this table is used by the operator to hold the documents and cards he is working with.
3. Fuses — there are many delicate electrical circuits in the tabulator (as well as all other IBM machines.) The fuses are installed to protect these circuits from damage.
4. Summary-Punch Cable Receptacle — it is possible to accumulate information in the 402 and then cause this information to be punched into an attached 514 Reproducer. The reproducer is attached to the 402 by means of a cable - this cable is hooked into the summary-punch cable receptacle.
5. Non-Print Runout etc. - these switches and buttons are used to control special types of machine operations and will be discussed in later lessons. See Figure 2.

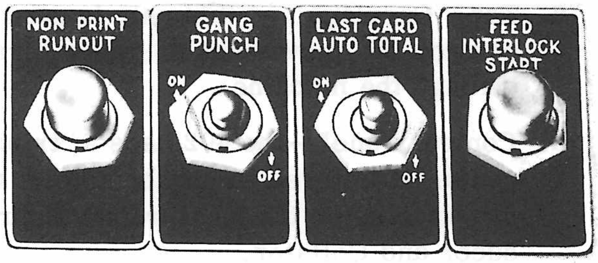


Figure 2.

6. Set-Up Change Switches — the operation of the 402 is controlled by a control panel. These switches permit the operator to change the panel's function without having to physically remove

any wires from the panel. See Figure 3.

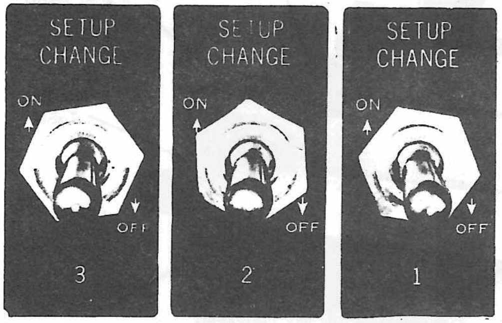


Figure 3.

7. Print Unit — printing is accomplished from type-bars which are very much like the 552 Interpreter typebars. There are 88 typebars all told. Figure 4 is a close-up view of the typebars.

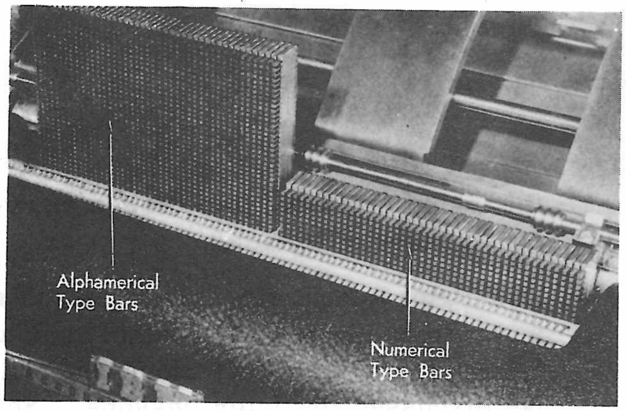


Figure 4.

8. Tape Carriage — this unit is used to control the movement of paper forms through the machine.
9. Control Panel — the 402 uses a "triple" panel. It is three times the size of the panels used on the Interpreter, Reproducer and Collator.
10. Card Feed — cards entering the machine are placed in this hopper, face down, 9 edge in.
11. Card Stacker — after the cards have been processed, they enter the stacker.
12. Start, Stop and Final Total Keys — the start and stop keys are used to start and stop the machine. The final total key is used to clear the counters (accumulators or registers) prior to starting a job or at the end of a job to cause accumulated figures to print.
13. Signal Lights — these lights will turn on when the machine stops, when a card fails to feed, when a fuse burns out, or when the machine exhausts its supply of paper forms. Figure 5 is a close-up of these lights and the keys discussed in paragraph 12 above.

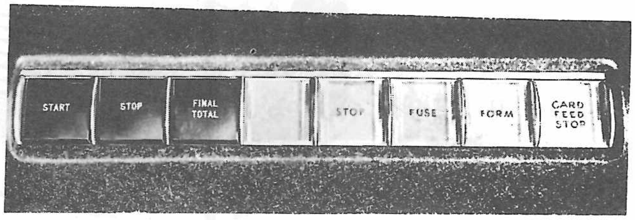


Figure 5.

13.2 THE PRINT UNIT

The 402 prints information from 88 typebars. See Figure 6. The 43 typebars to the left are called Alphamerical typebars. Each typebar contains all the letters of the alphabet (A-Z), the ten digits (0-9) and a special character (usually a "&" symbol.)

The 45 typebars to the right are called Numerical typebars. Each of them contains the digits 0-9 and a special character, either an "*" or a "CR" symbol. The 402 prints at the rate of either 80 or 100 lines per minute. All 88 typebars or any of them can print at one time.

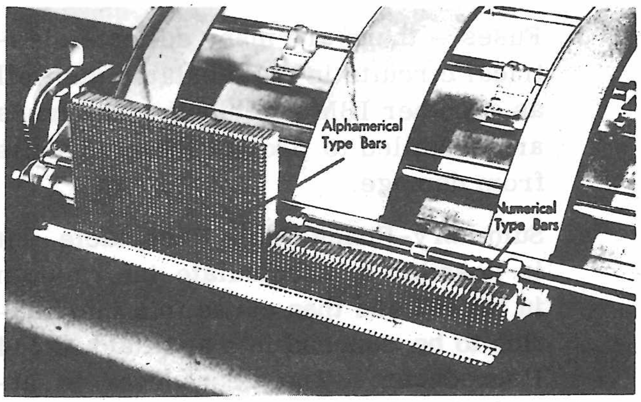


Figure 6.

13.3 THE READING UNIT

The reading unit is located right in back of and under the feed hopper. It consists of two sets of 80 brushes each. See Figure 7. The first set of brushes the card will pass under is called "2nd brushes or 2nd reading." The second set of brushes that will read the card is called "3rd brushes or 3rd reading." The card will then enter the stacker.

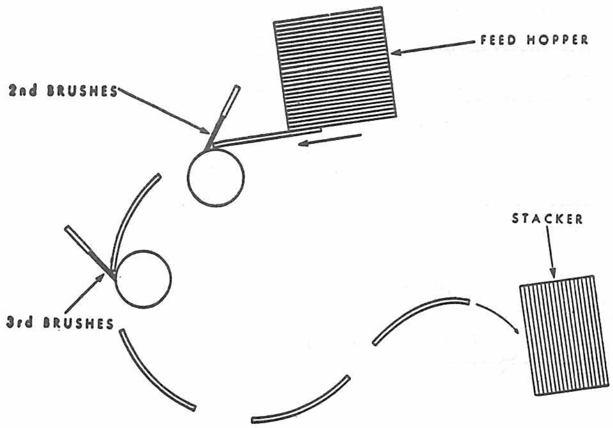


Figure 7. Path of the card through the 402.

13.4 PRINTING

The first operation we are going to study is the type of operation where we intend to print a line of information for every card passing through the machine. This type of operation is called "listing." There are two types of listing operations: (1) Numerical listing — this type of listing operation is one where the information to be listed is numerical only. Since all 88 typebars contain the digits 9-0, we can use any of them to print our data; (2) Alphabetical listing — here we expect that some of the data to be printed is alphabetical in character. Remember, that only the left-hand 43 typebars contain the alphabetical characters A-Z. Therefore, we will have to print alphabetical information from these typebars.

Each of the typebars is numbered and is referred to by number. (Remember, the typebars in the Interpreter were also numbered.) We select the typebars we want to print from.

The alphamerical typebars are numbered from 1-43. The typebar on the extreme left is typebar 1; the typebar on the extreme right is typebar 43. The numeric typebars are numbered the same way from 1-45.

Figure 8 is a diagram of the 402 control panel. Let us discuss those features of the panel which are used in our listing operation. (Note that the actual panel is approximately 11"x19" in size). The diagram has been reduced to fit within the size limitation of this page.)

A) Second Reading (M-N, 1-40) — these hubs are exits for the impulses read from the card as it passes under the 2nd reading brushes. They are normally wired to Normal Zone Entry (E) to signal to the machine that the information to be printed is alphabetical in character.

B) Third Reading (0-P, 1-40) - these hubs are exits for the impulses read from the card as it passes under the 3rd reading brushes.

C) Normal Alphamerical Print Entry (Q, 1-43) — these are entry hubs for impulses from third reading. To print alphabetic information, the zones (0, 11 & 12) read by second reading and wired to normal zone entry are combined with the digits read by third reading and wired to normal alphamerical print entry to form the alphabetic character. To print numerical information from these typebars we would wire ONLY from third reading to normal alphamerical print entry. You do not wire second reading to normal zone entry when the information in the card is numerical.

D) Numerical Print Entry (R, 1-44; S, 44) — these are entry hubs which are wired from third reading to print numerical information.

E) Normal Zone Entry (L, 1-43) — these hubs are entry hubs for impulses read from second reading. They will accept

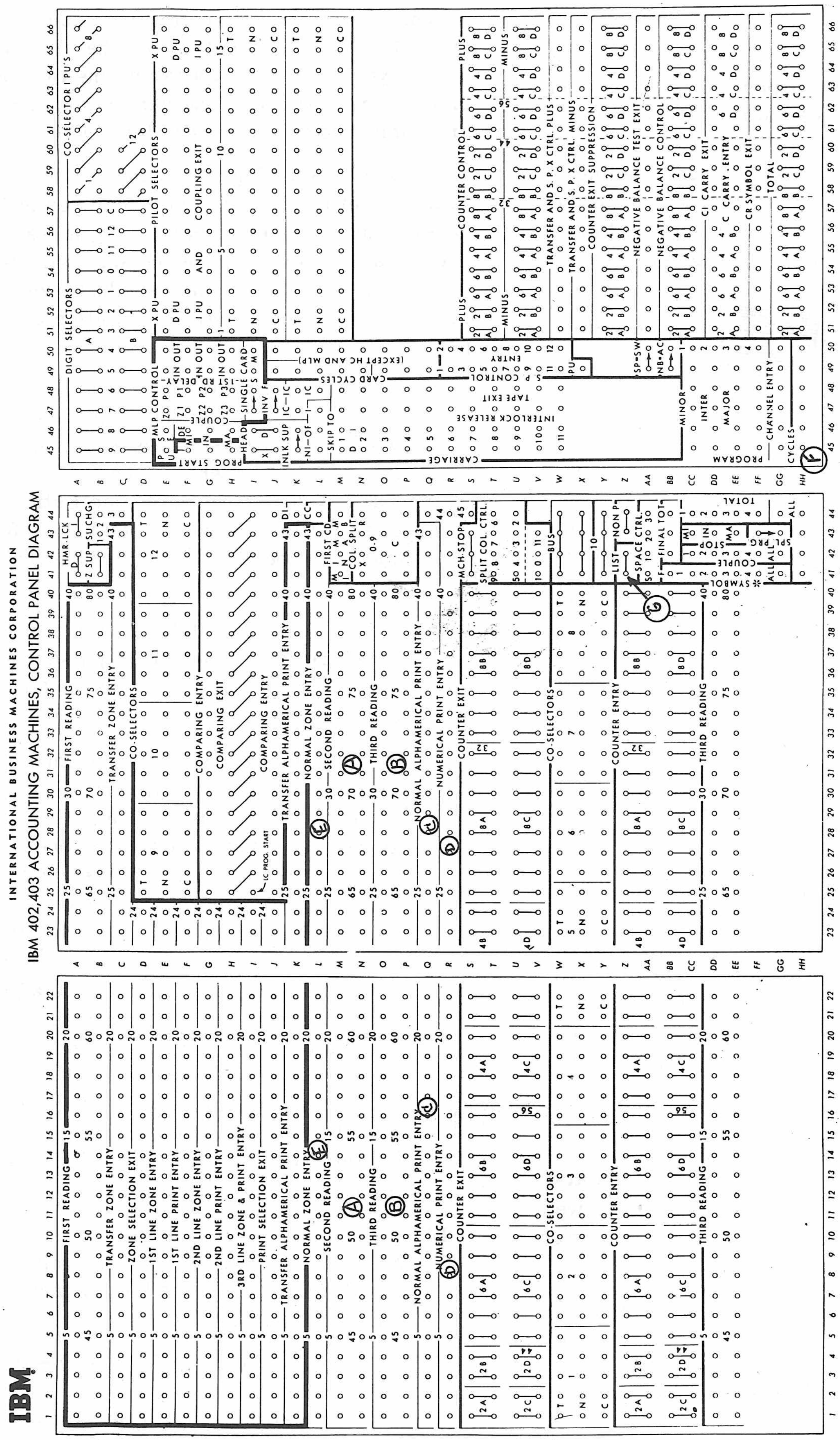

IBM
INTERNATIONAL BUSINESS MACHINES CORPORATION
IBM 402,403 ACCOUNTING MACHINES, CONTROL PANEL DIAGRAM
FIRST READING
TRANSFER ZONE ENTRY
ZONE SELECTION EXIT
1ST LINE ZONE ENTRY
1ST LINE PRINT ENTRY
2ND LINE ZONE ENTRY
2ND LINE PRINT ENTRY
3RD LINE ZONE & PRINT ENTRY
PRINT SELECTION EXIT
TRANSFER ALPHAMERICAL PRINT ENTRY
NORMAL ZONE ENTRY
SECOND READING
THIRD READING
NORMAL ALPHAMERICAL PRINT ENTRY
NUMERICAL PRINT ENTRY
COUNTER EXIT
CO-SELECTORS
COUNTER ENTRY
COMPARING ENTRY
COMPARING EXIT
IC PROG. START
HMR-LCK
Z SUP
SUCHG
FIRST CD
COL. SPLIT
MCH-STOP
SPLIT COL. CTRL.
BUS
LIST
NON P
SPACE CTRL
FINAL TOT
SYMBOL
COUPLE
STOP
SPL PRG
ALL
TOTAL
DIGIT SELECTORS
CO-SELECTOR I PU'S
PILOT SELECTORS
X PU
D PU
I PU
COUPLING EXIT
AND
MLP CONTROL
PROG START
DELAY
IN OUT
1ST RD
SINGLE CARD
HEAD
INV F
INLK SUP
SKIP TO
CARD CYCLES
(EXCEPT HC AND MLP)
CARRIAGE
TAPE EXIT
INTERLOCK RELEASE
S P CONTROL
ENTRY
COUNTER CONTROL
PLUS
MINUS
TRANSFER AND S. P. X CTRL. PLUS
TRANSFER AND S. P. X CTRL. MINUS
COUNTER EXIT SUPPRESSION
NEGATIVE BALANCE TEST EXIT
NEGATIVE BALANCE CONTROL
SP-SW
NB-AC
MINOR
INTER
MAJOR
PROGRAM
CI CARRY EXIT
CARRY ENTRY
CR SYMBOL EXIT
CHANNEL ENTRY
CYCLES
A
B
C
D
E
F
G

Figure 8.

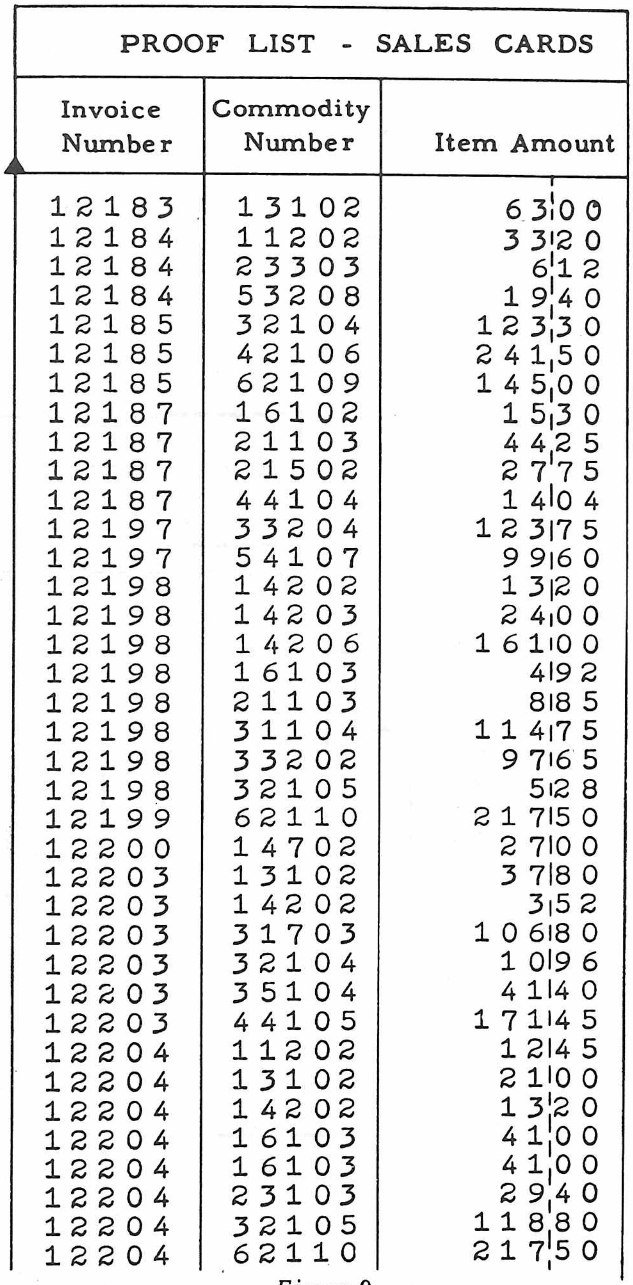
zone impulses only to position the alphamerical typebars to print alphabetic information. The impulses which enter these entry hubs are combined with the impulses which enter the correspondingly numbered normal alphamerical print entry hubs to cause the printing of an alphabetic character.

F) All Cycles (HH, 41-50) — these hubs emit a machine-manufactured impulse for every machine cycle. They are normally wired to the "list" hubs to cause printing.

G) List (Z, 41-42) — these two hubs are entry hubs. When impulsed, they cause the typebars to rise and information to print. Note that the 402 unlike the interpreter will not print unless control panel wiring tells it to print.

Sample Problem:

Figure 9 represents a listed report which has been prepared from cards such as the one illustrated in Figure 10. As the information required to be listed is numeric in nature, it can be printed from any of the 88 typebars. The typebars selected are those which will print the report in the desired format with spaces between the fields to offer better readability. Figure 11 is the control panel diagram required to do this job.



PROOF LIST - SALES CARDS

Invoice Number	Commodity Number	Item Amount
12183	13102	63 00
12184	11202	33 20
12184	23303	6 12
12184	53208	19 40
12185	32104	123 30
12185	42106	241 50
12185	62109	145 00
12187	16102	15 30
12187	21103	44 25
12187	21502	27 75
12187	44104	14 04
12197	33204	123 75
12197	54107	99 60
12198	14202	13 20
12198	14203	24 00
12198	14206	161 00
12198	16103	4 92
12198	21103	8 85
12198	31104	114 75
12198	33202	97 65
12198	32105	5 28
12199	62110	217 50
12200	14702	27 00
12203	13102	37 80
12203	14202	3 52
12203	31703	106 80
12203	32104	10 96
12203	35104	41 40
12203	44105	171 45
12204	11202	12 45
12204	13102	21 00
12204	14202	13 20
12204	16103	41 00
12204	16103	41 00
12204	23103	29 40
12204	32105	118 80
12204	62110	217 50

Figure 9.

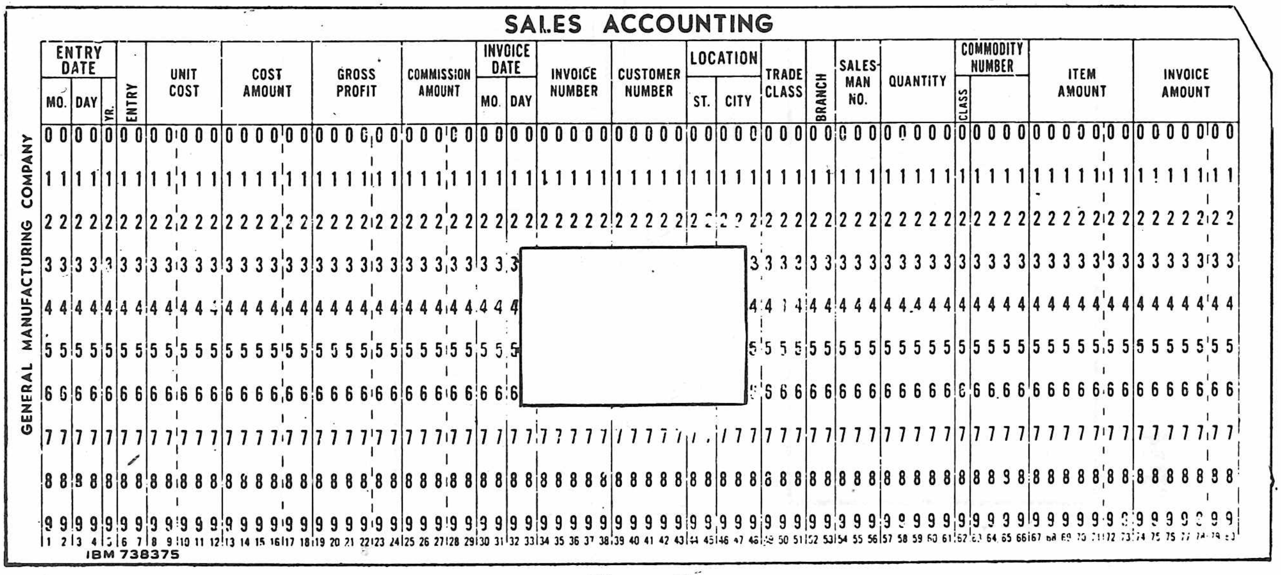


Figure 10.

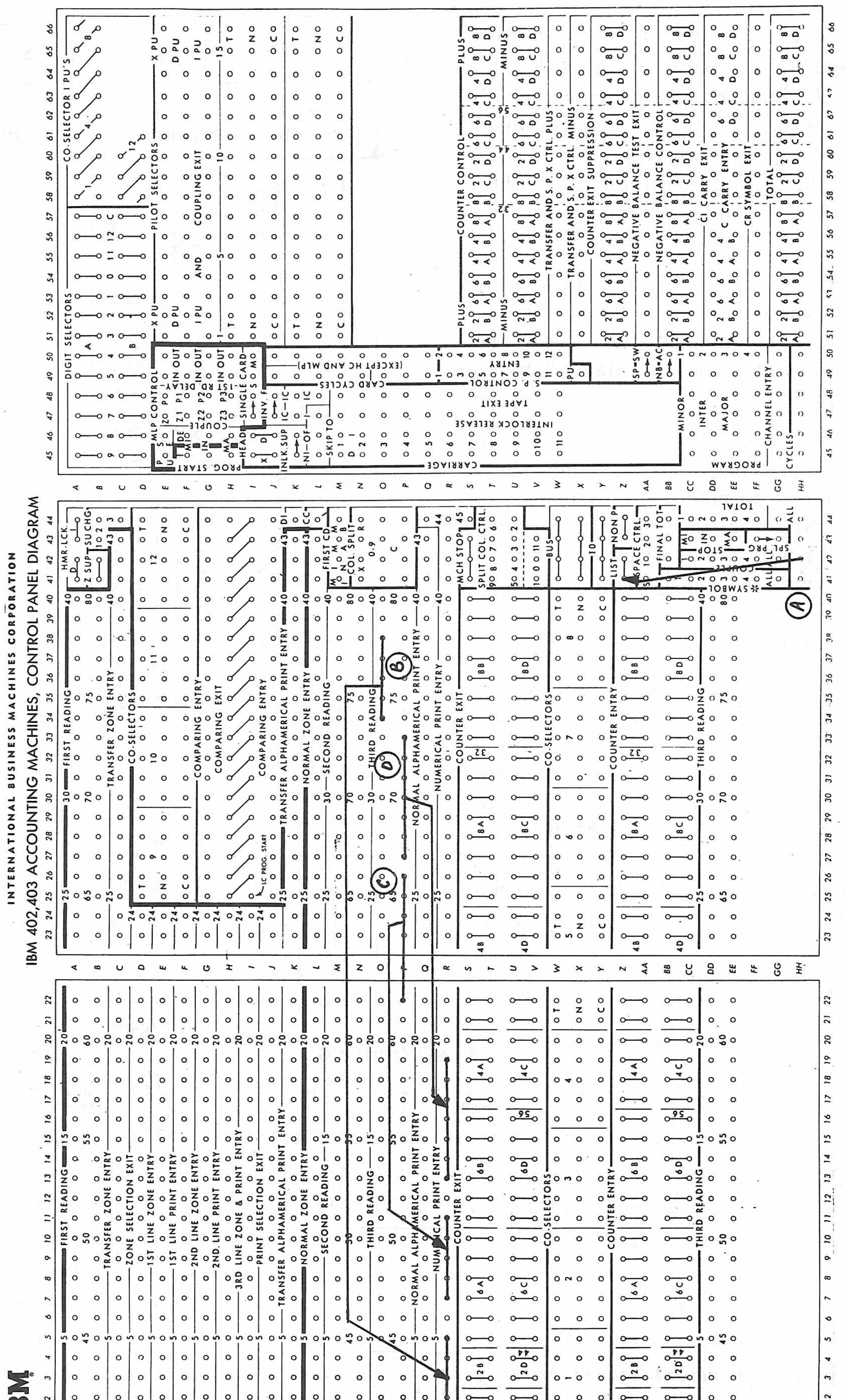

IBM
INTERNATIONAL BUSINESS MACHINES CORPORATION
IBM 402,403 ACCOUNTING MACHINES, CONTROL PANEL DIAGRAM
A
B
C
D
FIRST READING
TRANSFER ZONE ENTRY
ZONE SELECTION EXIT
1ST LINE ZONE ENTRY
1ST LINE PRINT ENTRY
2ND LINE ZONE ENTRY
2ND. LINE PRINT ENTRY
3RD LINE ZONE & PRINT ENTRY
PRINT SELECTION EXIT
TRANSFER ALPHAMERICAL PRINT ENTRY
NORMAL ZONE ENTRY
SECOND READING
THIRD READING
NORMAL ALPHAMERICAL PRINT ENTRY
NUMERICAL PRINT ENTRY
COUNTER EXIT
CO-SELECTORS
COUNTER ENTRY
COMPARING ENTRY
COMPARING EXIT
IC PROG. START
HMR. LCK.
Z SUP
SUCHG
FIRST CD.
COL. SPLIT
MCH STOP
SPLIT COL. CTRL.
BUS
LIST
NON P
SPACE CTRL.
FINAL TOT.
SYMBOL
ALL
TOTAL
DIGIT SELECTORS
CO-SELECTOR I PU'S
PILOT SELECTORS
COUPLING EXIT
AND
X PU
D PU
I PU
MLP CONTROL
PROG. START
COUPLE
HEADS
SINGLE CARD
INV. F
INLK. SUP
SKIP TO
CARD CYCLES
(EXCEPT HC AND MLP)
CARRIAGE
S. P. CONTROL ENTRY
TAPE EXIT
INTERLOCK RELEASE
COUNTER CONTROL
PLUS
MINUS
TRANSFER AND S. P. X CTRL. PLUS
TRANSFER AND S. P. X CTRL. MINUS
COUNTER EXIT SUPPRESSION
NEGATIVE BALANCE TEST EXIT
NEGATIVE BALANCE CONTROL
CI CARRY EXIT
CARRY ENTRY
CR SYMBOL EXIT
TOTAL
MINOR
INTER
MAJOR
PROGRAM
CHANNEL ENTRY
CYCLES

Figure 11.

Notes on Figure 11:

A) The All Cycles impulse is wired to List to cause the typebars to print for every macnine cycle.

B) The field invoice number (c. c. 34-38) is wired to numeric t. b. 1-5.

C) The field commodity number (c. c. 62-66) is wired to t. b. 7-11.

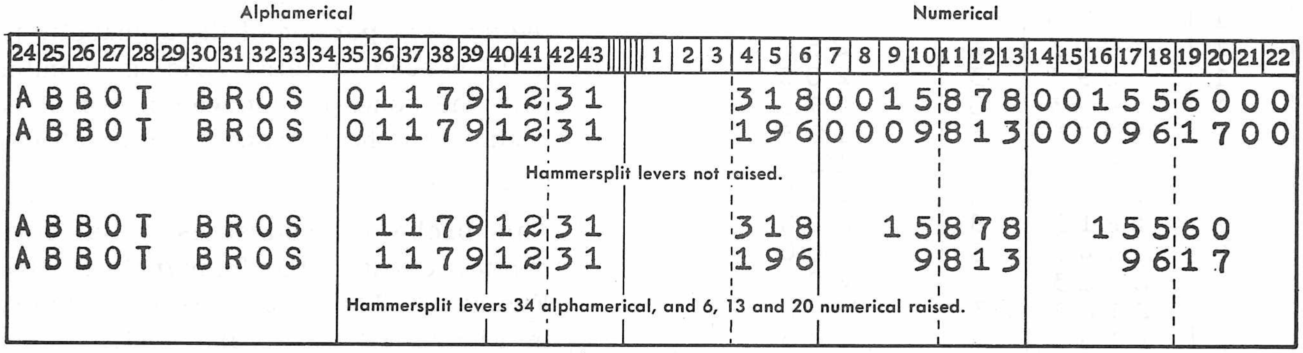
D) The field item amount (c. c. 67-73) is wired to t. b. 13-19.

As each card feeds through the machine, the information read at the third reading brushes is transmitted to the designated typebars and will print.

A peculiarity of 402 numeric typebars is that they will print mechanical zeroes to the right of the units position of the fields being printed. In addition, zeroes which were punched in the high order position of a field will also print. See Figure 12 for an illustration of how printing would appear. The first two lines show how the extra zeroes would print. To eliminate these extra zeroes, we make use of devices called hammersplit levers. There is a hammersplit lever for every typebar. They are located right in front of the typebars. See Figure 13 for a close-up view of the hammersplit levers.

To eliminate extra zeroes, raise the hammersplit levers which correspond to the units position of each field being printed. The last two lines on Figure 12 illustrate how the line would appear if the proper hammersplit levers were raised. They are raised using the key.

In our problem as illustrated in Figure 11, hammersplit levers for the numeric typebars 5, 11 & 19 would be raised.



```
                Alphamerical                                            Numerical
24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 |||| 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
ABBOT   BROS   01179 12 31     318 0015878 00155 6000
ABBOT   BROS   01179 12 31     196 0009813 00096 1700
               Hammersplit levers not raised.

ABBOT   BROS    1179 12 31     318   15878   155 60
ABBOT   BROS    1179 12 31     196    9813    96 17
Hammersplit levers 34 alphamerical, and 6, 13 and 20 numerical raised.
```

Figure 12.

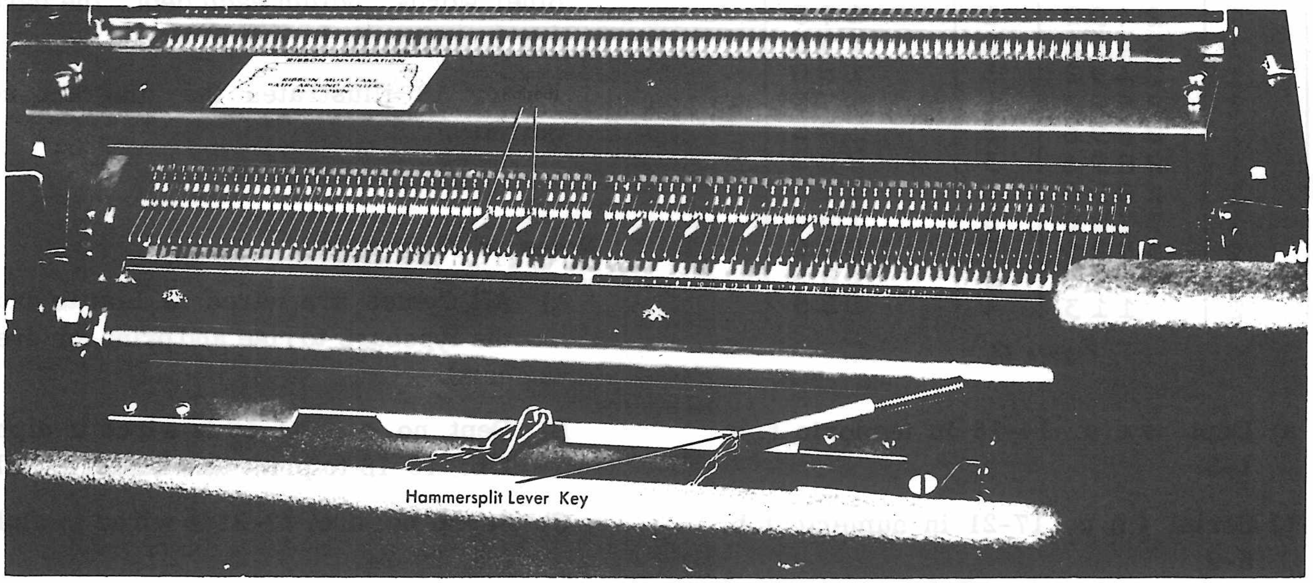


Figure 13. Hammersplit levers.

Exercise: Diagram the following exercise on the control panel diagrams provided. Check your solution with the school solution which will be found in the back of this lesson:

1. We are to detail print (list) a report of payroll deductions to appear as in Figure 14 from cards such as the sample that is illustrated by Figure 15. Print the following fields in the typebars indicated:

PAYROLL DEDUCTIONS			
Dept.	Serial No.	Ded'n Code	Ded'n. Amount
1	206	1	375
1	206	4	492
1	206	5	150
1	342	3	200
1	342	5	125
1	518	1	200
1	518	4	250
1	615	2	200
1	615	5	150
1	703	1	250
1	893	3	200
1	893	5	175
1	1075	1	125
1	1075	5	125
1	1219	1	175
1	1219	8	200
1	1741	5	100
1	2183	1	200
1	2183	3	200
1	2183	5	125
1	2470	1	175
1	2470	5	125
1	2492	1	175
1	2492	2	175
1	2492	5	150
1	2896	1	175
1	2896	2	125
1	2896	3	200
1	2896	5	175
1	3720	5	150
1	3720	9	1000
2	113	2	125
2	113	4	125

Figure 14.

a) Dept. # c.c. 14-16 in numeric t.b. 1-3.

b) Serial # c.c. 17-21 in numeric t.b. 5-9.

c) Ded'n code c.c. 22-23 in numeric t.b. 11-12.

d) Ded'n amount c.c. 72-76 in numeric t.b. 14-18.

e) Indicate on the diagram with an "x" the hammersplit levers to be raised.

Sample Problem:

In this problem we are going to illustrate the required wiring to print alphabetic information. Remember that alphabetic information can only be printed in the alphamerical typebars. To print alphabetic information, we must do two things: (1) the zone portion of the alphabetic characters will be read from second reading at the time the card passes under the second reading brushes and they will position the typebars to print alphabetic information (this is called "zoning" the typebars); (2) the numeric portion of the alphabetic field will be read at third reading, combined with the zone portion which was already read, and the alphabetic character will be printed.

This problem requires us to list payroll master cards in the format illustrated in Figure 16. These cards (see sample card in Figure 17) have been sorted into sequence by Serial No. and then by Dept. In other words, within each dept. the cards are in sequence by serial no.

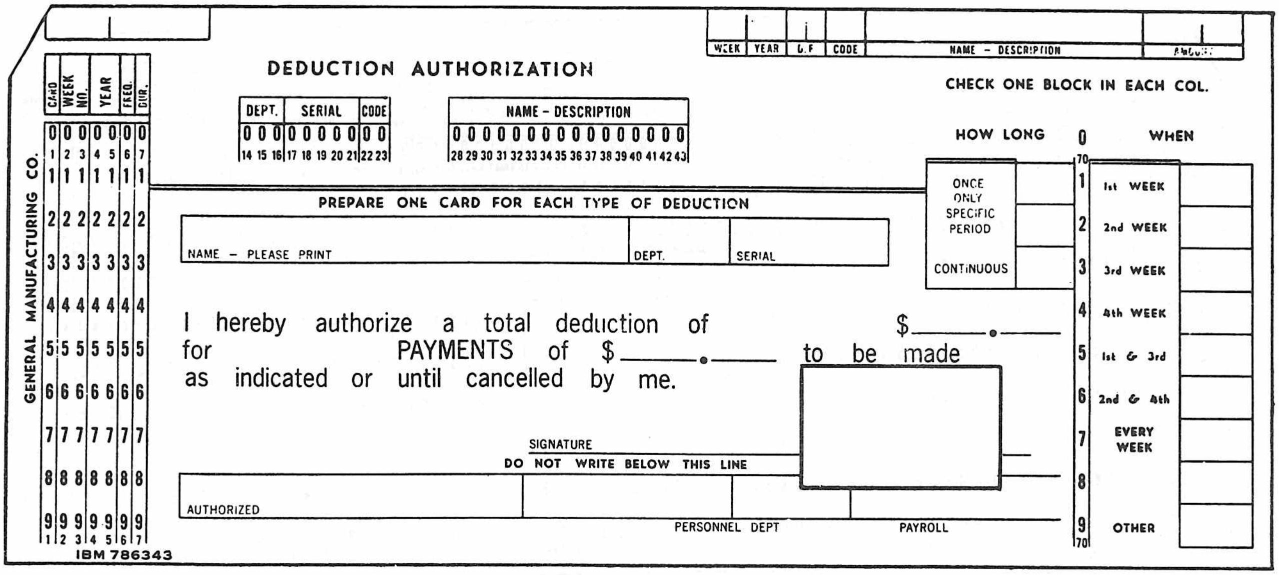
Figure 18 illustrates the diagram required.

Notes on Figure 18:

A) All Cycles are wired to List to cause the typebars to rise and print for every card.

B) Dept. no. c.c. 14-16 is wired to alpha. t.b. 16-18 to print this numeric field.

C) Serial no. c.c. 17-21 is wired to alpha. t.b. 20-24.



GENERAL MANUFACTURING CO.

CARD | WEEK NO. | YEAR | FREQ. | DUR.

WEEK | YEAR | C.F | CODE | NAME – DESCRIPTION | AMOUNT

DEDUCTION AUTHORIZATION

DEPT. | SERIAL | CODE

NAME – DESCRIPTION

CHECK ONE BLOCK IN EACH COL.

PREPARE ONE CARD FOR EACH TYPE OF DEDUCTION

NAME – PLEASE PRINT | DEPT. | SERIAL

I hereby authorize a total deduction of $_____._____ for PAYMENTS of $_____._____ to be made as indicated or until cancelled by me.

SIGNATURE

DO NOT WRITE BELOW THIS LINE

AUTHORIZED | PERSONNEL DEPT | PAYROLL

HOW LONG	☐
ONCE ONLY	☐
SPECIFIC PERIOD	☐
CONTINUOUS	☐

	WHEN	☐
1	1st WEEK	☐
2	2nd WEEK	☐
3	3rd WEEK	☐
4	4th WEEK	☐
5	1st & 3rd	☐
6	2nd & 4th	☐
7	EVERY WEEK	☐
8		☐
9	OTHER	☐

IBM 786343

Figure 15.

PAYROLL MASTER CARDS

Dept.	Serial No.	Employee Name	Occup. Code	Reg.Rate
1	206	W V ASTUR	23	1375
1	342	F A ATCHISON	117	1000
1	518	H B BAKER	4	1325
1	615	L F BILLINGS	26	1150
1	703	E J BRACKETT	5	1000
1	893	A F CASPER	27	1400
1	1075	E C COLLINS	4	1250
1	1103	L F CUNNINGHAM	25	1175
1	1219	F A DAVENPORT	1	1200
1	1302	H F DENNIS	40	1100
1	1741	B A ENGELS	1	900
1	2092	A B FARRELL	25	1300
1	2183	M J FOSTER	24	1150
1	2470	B J GRAHAM	9	1350
1	2492	E L GRESHAM	6	1000
1	2896	L B HENDERSON	6	1325
1	3720	R J JOHNSON	25	1250
2	113	F J ACKERLY	10	1500
2	867	M C CARGIN	6	900
2	1396	G A DRISCOLL	9	1000
2	1569	C L EDWARDS	10	1150
2	4482	R C MURRAY	2	1200
2	4891	S C OAKLAND	6	1050
2	6601	P S RUGGLES	6	950

Figure 16.

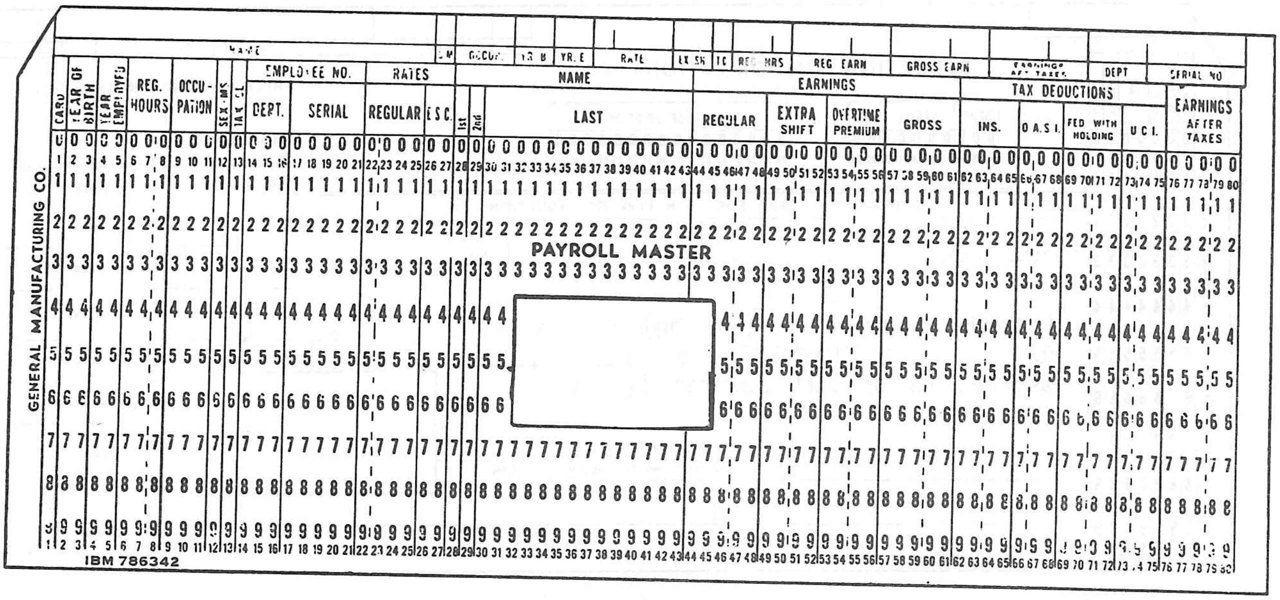


Figure 17.

D) Employee name c.c. 28-43 is wired to normal zone entry 26, 28, 30-43 to "zone the typebars" for printing alphabetic information. Note how some typebars are unused to provide the necessary spaces on the report.

E) Employee name c.c. 28-43 is now wired to the correspondingly numbered alphamerical typebars to complete the wiring for printing the alphabetic field.

F) Occup. code c.c. 9-11 is wired to num. t.b. 1-3.

G) Reg. rate c.c. 22-25 is wired to num. t.b. 5-8.

H) The required hammersplit levers are indicated.

I) Note the use of the form layout to facilitate preparation of the wiring diagram. The field heading and card columns are indicated over the selected typebars. A space equivalent in size to a typebar is provided between alpha. t.b. 43 and num. t.b. 1. This is called a ribbon guide.

Exercise: Diagram the following exercise on the control panel diagrams provided. Check your solution with the school solution.

2. We are to detail print a report of Accounts Receivable Master cards. The report is illustrated in Figure 19; a sample card is illustrated in Figure 20. Print the following fields in the typebars indicated:

a) Cust. #c.c. 39-43 in alpha t.b. 16-20.

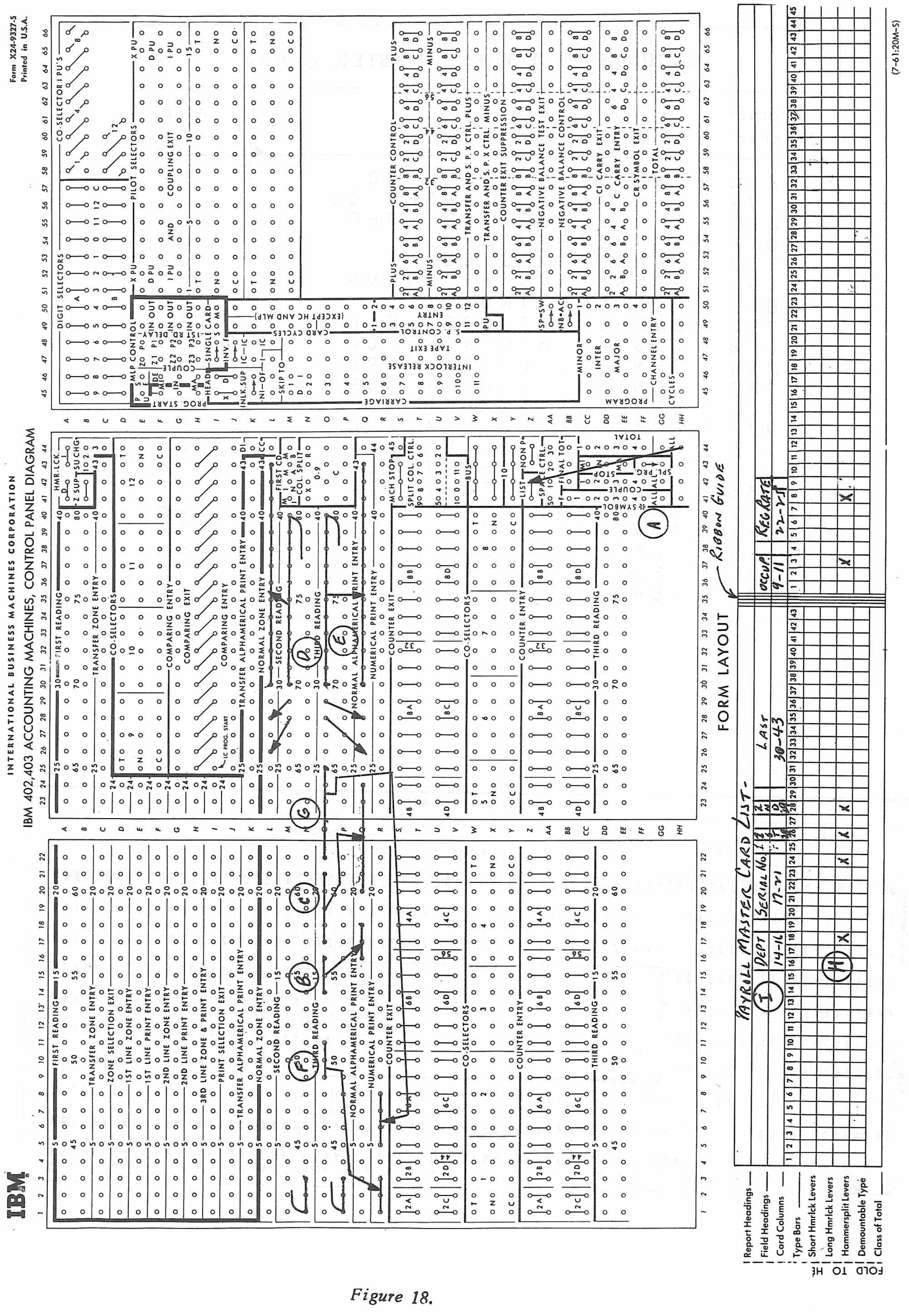
b) Cust. name c.c. 8-29 in alpha t. b. 22-43.

c) Salesman no. c.c. 54-56 in num. t.b. 1-3.

d) Indicate the hammersplit levers to be raised and also the field headings and card columns in the form layout portion of the diagram.

Note:

If, when attempting to print an alphabetic field, you wire only from second reading to normal zone entry, nothing will print from those typebars. Should you wire from third reading to normal alphamerical print entry and forget to wire from second reading to normal zone entry, the numeric portion of the alphabetic character would print. When printing a mixed alpha-numeric field, like an address — "1234 North Main St." — you wire it as though it were a whole alphabetic field. Since the digits have no zone punch, they will print as digits.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IBM 402,403 ACCOUNTING MACHINES, CONTROL PANEL DIAGRAM
IBM
Form X24-9327-5
Printed in U.S.A.
FORM LAYOUT
PAYROLL MASTER CARD LIST
DEPT
14-16
SERIAL NO.
17-21
LAST
30-43
OCCUP.
9-11
REG. RATE
22-25
RIBBON GUIDE
A
B
C
D
E
F
G
H
I
Report Headings
Field Headings
Card Columns
Type Bars
Short Hmrlck Levers
Long Hmrlck Levers
Hammersplit Levers
Demountable Type
Class of Total
FOLD TO HERE
(7-61:20M-S)

Figure 18.

ACCOUNTS RECEIVABLE MASTER CARDS

Customer Number	Customer Name	Sales-man
1281	AMERICAN STEEL CO	58
2179	APALACHIN LUMBER CO	35
2283	B J E SERVICE CORP	69
3076	BARRETT MACHINE	7
4123	BENSON MFG CO	66
6195	BROWN AND WILLIAMS	46
6843	BUNDLEE INC	46
7792	BYRNE AUTOMOBILE CO	37
8062	CASTLE HARDWARE CO	13
8257	CENTRAL UNION SUPPLY	71
10723	CENTRAL VALLEY CORP	69
11905	CHALLIS ALMERS	23
11934	CHANEL WHOLESALE CO	79
11975	CHENANGO RAILROAD CO	85
14910	CHOLMAR FURNITURE CO	57
15035	COLUMBIA MFG CO	66
16771	COOK AND EDWARDS	18
19285	COVENTRY OIL	53
21217	CRESCENT BELT CO	85
29031	DENNIS MFG CO	79
29134	DEPOSIT DIST CO	26

Figure 19.

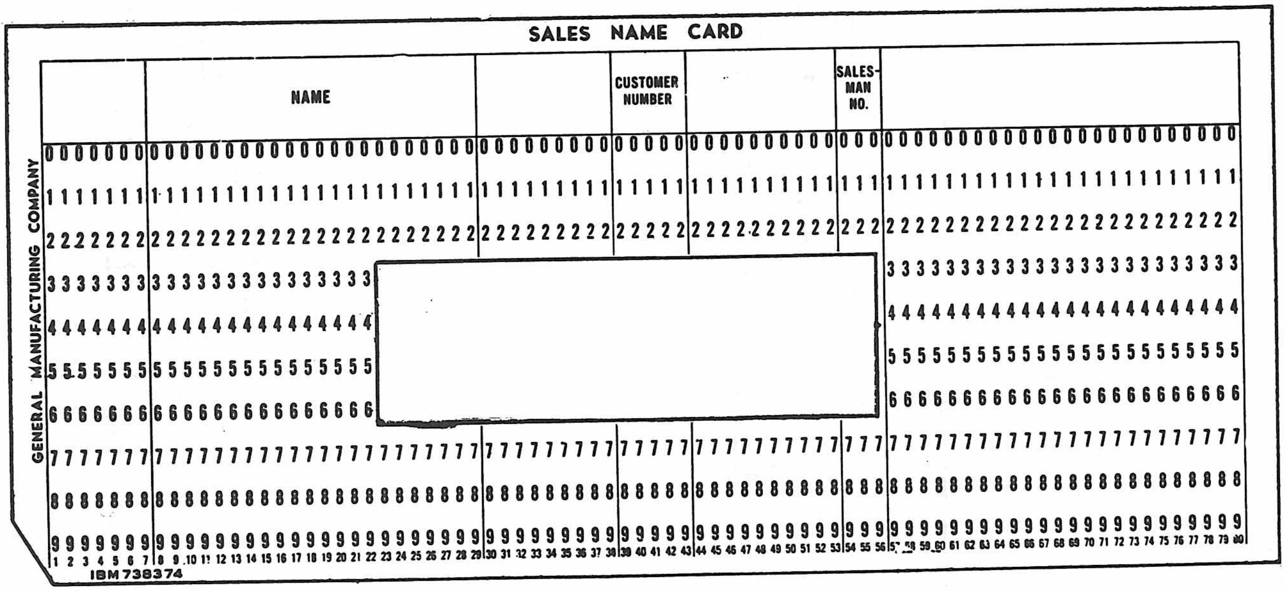


Figure 20.

GLOSSARY

All Cycles — Each of these hubs emits a machine manufactured impulse for every machine cycle.

Alphabetic Field — Any field which consists wholly or partly of alphabetic characters.

Alphamerical Typebars — There are 43 alphamerical typebars. They can be used to print either alphabetical or numerical data. They are normally wired from third reading.

Detail Printing — A tabulating function where each card being processed will create a line of printing.

List Hubs — Entry hubs which when impulsed will cause the typebars to rise and print.

Listing — Another term used to denote a detail printing job.

Hammersplit Levers -- Devices used to prevent extra zeroes from printing on a report. There is a hammersplit lever for each of the 88 typebars.

Normal Alphamerical Print Entry — entry hubs used to cause printing from the alphamerical typebars.

Normal Zone Entry — Entry hubs which are used to "zone" the typebars as part of the alphabetical printing report.

Numeric Field — A field which consists wholly of digits.

Numerical Print Entry — Entry hubs used to cause printing in the numeric typebars. There are 45 numeric typebars.

Second Reading — the name given to the 80 brushes which first read the card. They are used to read zone punches which are directed to normal zone entry.

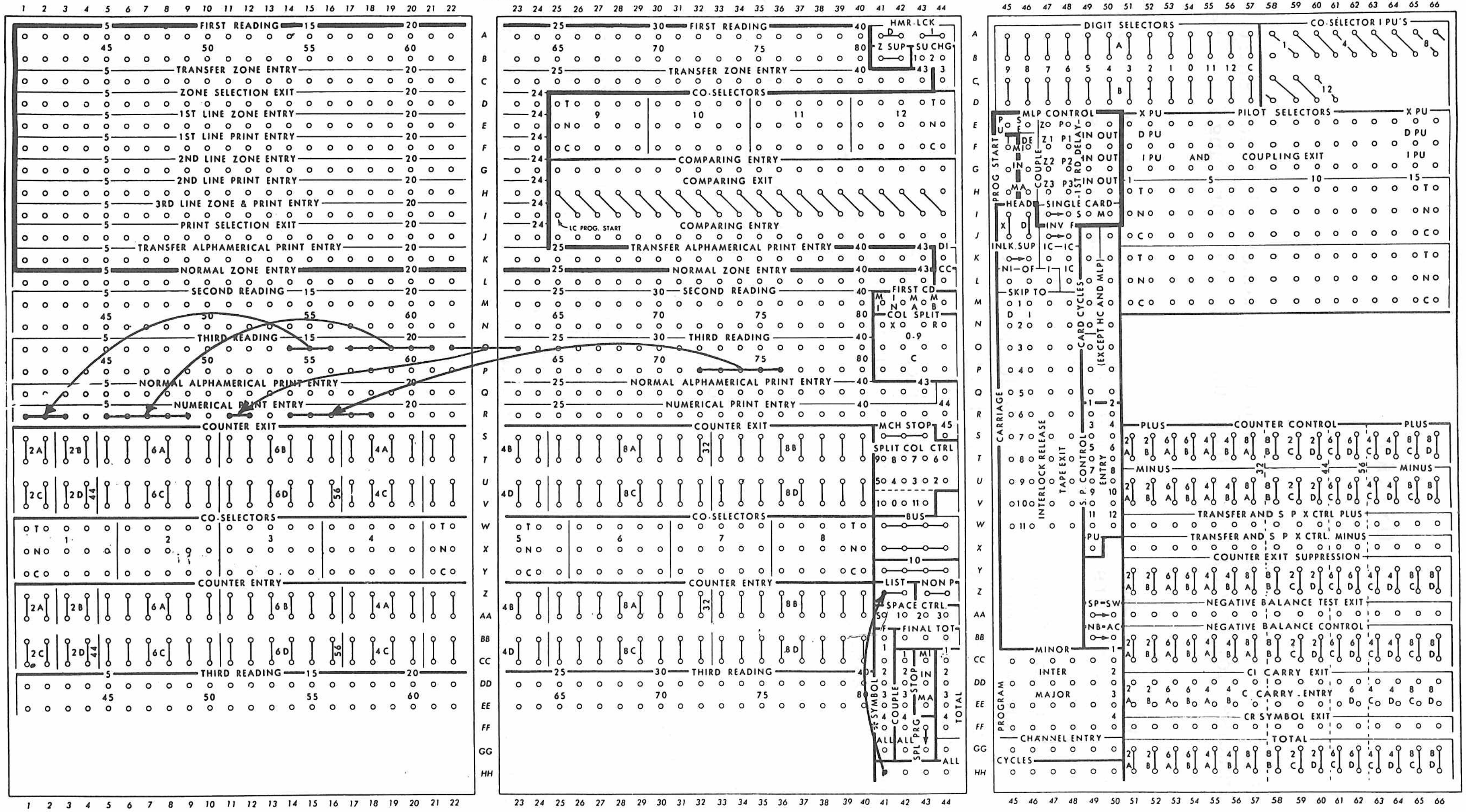
Third Reading — the name given to the 80 brushes which next read the card. Impulses from third reading are wired to either alphanumerical or numerical typebars to cause printing.

IBM

INTERNATIONAL BUSINESS MACHINES CORPORATION

IBM 402,403 ACCOUNTING MACHINES, CONTROL PANEL DIAGRAM

Form X24-9327-5
Printed in U.S.A.

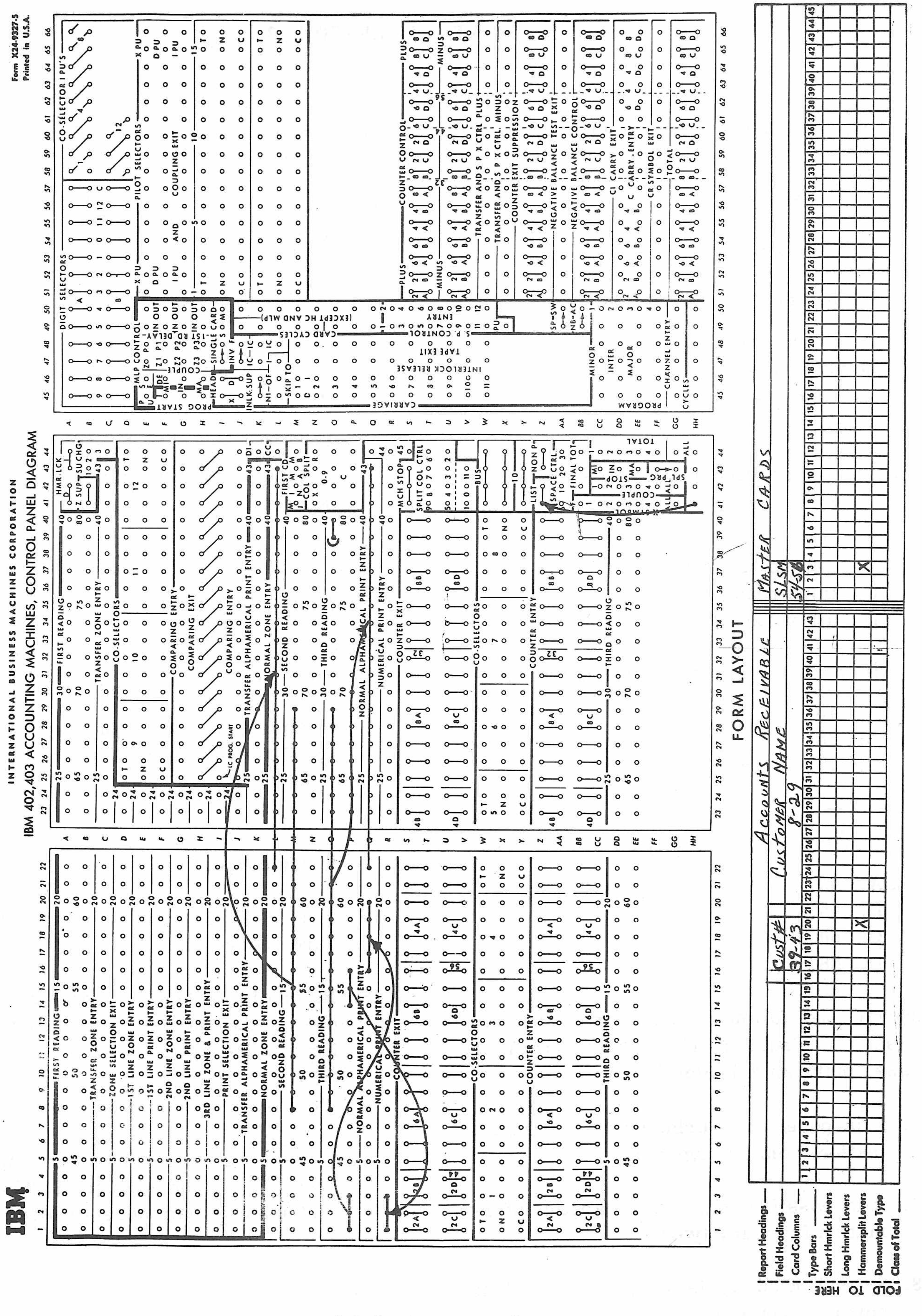


FORM LAYOUT

Report Headings																																											
Field Headings																																											
Card Columns																																											
Type Bars	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Short Hmrlck Levers																																											
Long Hmrlck Levers																																											
Hammersplit Levers																																											
Demountable Type																																											
Class of Total																																											

Report Headings									PAYROLL DEDUCTIONS																																				
Field Headings	DEPT				SERIAL #						CDE			AMOUNT																															
Card Columns	14-16				17-21						22-3			72-76																															
Type Bars	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Short Hmrlck Levers																																													
Long Hmrlck Levers																																													
Hammersplit Levers			X						X			X						X																											
Demountable Type																																													
Class of Total																																													

Solution to exercise 1.



Solution to exercise 2.

EXAMINATION – LESSON 13

1. The 402 accounting machine contains:
   - A. 43 typebars
   - B. 45 typebars
   - C. 80 typebars
   - D. 88 typebars

2. Cards enter the machine –
   - A. face down, 9 edge in
   - B. face down, 12 edge in
   - C. face up, 9 edge in
   - D. face up, 12 edge in

3. The first station which reads the card is called:
   - A. first reading
   - B. second reading
   - C. third reading
   - D. all of the above are incorrect

4. How many numeric typebars are there:
   - A. 43
   - B. 88
   - C. 45
   - D. 80

5. How many alphabetic typebars are there:
   - A. 43
   - B. 45
   - C. 80
   - D. 88

Answer the following questions True or False. If True, mark an X in Box A; if False, mark an X in Box B.

6. It is possible to print numerical information from any typebars.

7. It is possible to print alphabetic information from any typebar.

8. Second reading is normally wired to normal zone entry.

9. Detail printing means printing a line for every card passing through the machine.

10. The All Cycles hub emits an impulse for every machine cycle.

11. To print a numeric field, you must zone the typebars.

12. Hammersplit levers are used to cause zeroes to print.

13. A mixed alpha-numeric field is wired the same way a wholly alpha field would be wired.

Refer to Figure 21 and answer the following questions True or False.

14. c.c. 10-13 is an alphabetic field. It is wired correctly.

15. Assume c.c. 10-13 contains the letters "ABCD." The 402 would print this as "1234."

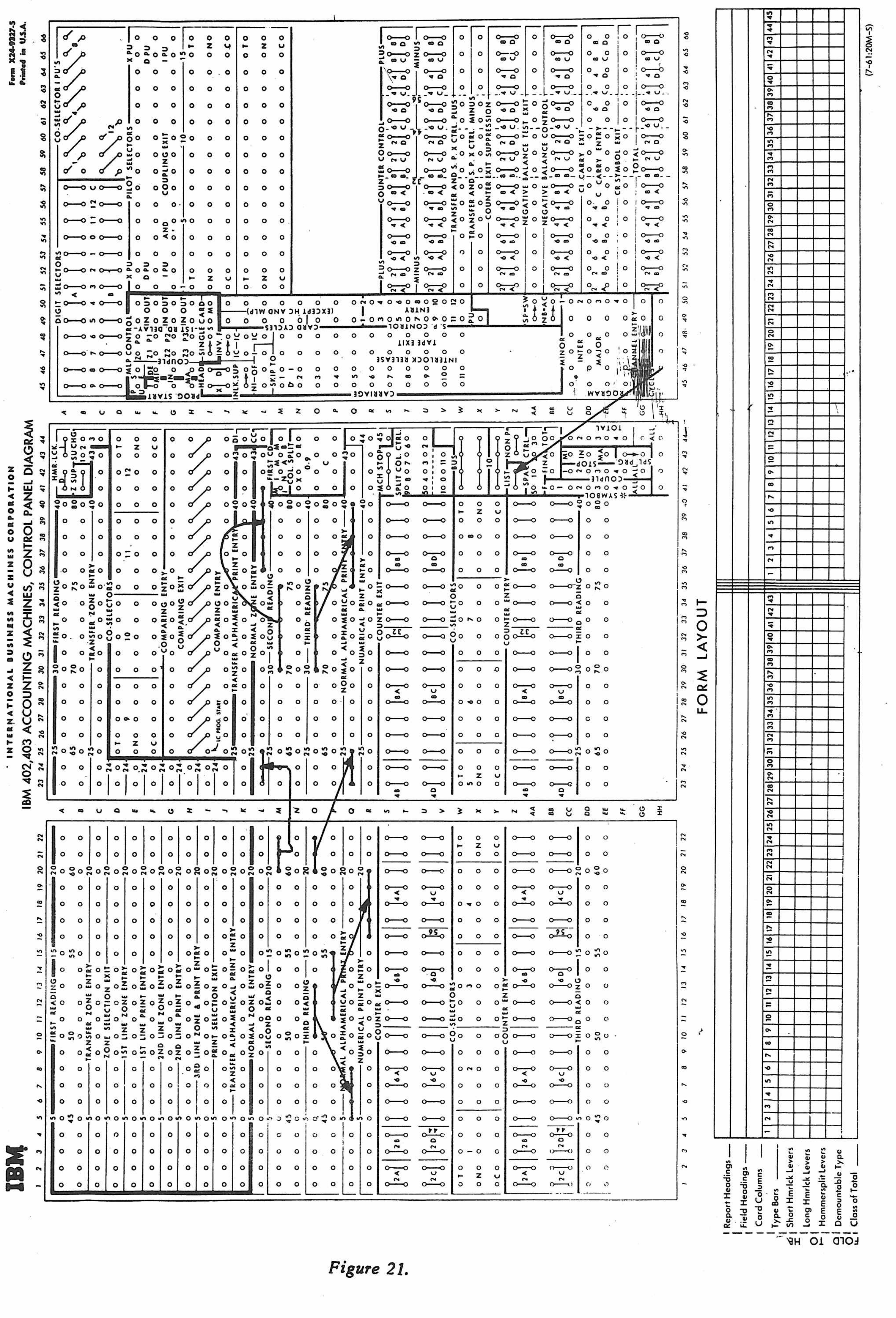
16. c.c. 20-22 is an alphabetic field. It is wired correctly.

17. c.c. 30-35 is an alphabetic field. It is wired correctly.

18. Hammersplit lever numeric 20 would be one of the hammersplit levers raised for this listing.

19. This is a detail printed report.

20. It would be correct to lift hammersplit levers for alpha typebars 8, 25 and 40, and numeric hammersplit lever 20.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1ST LINE PRINT ENTRY
2ND LINE ZONE ENTRY
2ND LINE PRINT ENTRY
3RD LINE ZONE & PRINT ENTRY
PRINT SELECTION EXIT
TRANSFER ALPHAMERICAL PRINT ENTRY
NORMAL ZONE ENTRY
SECOND READING
THIRD READING
NORMAL ALPHAMERICAL PRINT ENTRY
NUMERICAL PRINT ENTRY
COUNTER EXIT
CO-SELECTORS
COUNTER ENTRY
COMPARING ENTRY
COMPARING EXIT
IC PROG. START
FIRST CD.
COL. SPLIT
HMR. LCK.
MCH STOP
SPLIT COL. CTRL.
BUS
LIST
SPACE CTRL.
FINAL TOT.
SYMBOL
COUPLE
PRG. SPL
ALL
TOTAL
PROG. START
MLP CONTROL
DIGIT SELECTORS
PILOT SELECTORS
CO-SELECTOR I PU'S
COUPLING EXIT
DELAY IN OUT
HEADING SINGLE CARD
SKIP TO
INLK. SUP
CARD CYCLES
(EXCEPT HC AND MLP)
CONTROL ENTRY
TAPE EXIT
INTERLOCK RELEASE
CARRIAGE
PLUS
MINUS
COUNTER CONTROL
TRANSFER AND S. P. X CTRL. PLUS
TRANSFER AND S. P. X CTRL. MINUS
COUNTER EXIT SUPPRESSION
NEGATIVE BALANCE TEST EXIT
NEGATIVE BALANCE CONTROL
CI CARRY EXIT
C CARRY ENTRY
CR SYMBOL EXIT
MINOR
INTER
MAJOR
PROGRAM
CHANNEL ENTRY
FORM LAYOUT
Report Headings
Field Headings
Card Columns
Type Bars
Short Hmrlck Levers
Long Hmrlck Levers
Hammersplit Levers
Demountable Type
Class of Total
FOLD TO HERE
(7-61:20M-S)

Figure 21.

I.B.M. DATA PROCESSING AND COMPUTER PROGRAMMING

LESSON #14

TABLE OF CONTENTS

14.1) Addition in the 402

14.2) Comparing and Program Control

Glossary
Examination

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14.1 ADDITION IN THE 402

Addition is the accumulation of individual amounts to obtain totals. The type 402 tabulating machine has special devices in it which can add amounts and arrive at totals for these amounts. These special devices are called "counters." The operation of a counter is similar to that of an automobile speedometer. It contains a group of wheels each of which can add up to 9. When a wheel reaches its maximum total of 9 it causes a "carry" of one to enter the wheel to its left. Figures 1a-d illustrate counter wheels and their operation.

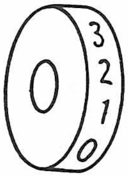


Figure 1a. A counter wheel.

1. Figure 1a illustrates a single counter wheel. As information enters the counter, the wheel will turn and increase.

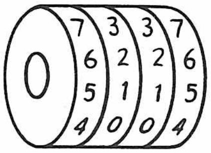


Figure 1b. A group of counter wheels.

2. Figure 1b illustrates a group of counter wheels. This represents a four-position counter and could add to a total of 9999.

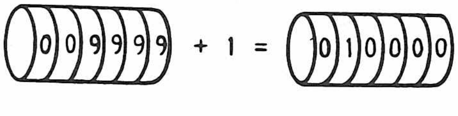


Figure 1c. Counter wheels change as a 1 is added.

3. Figure 1c illustrates a six-position counter which contains the total 9999. Adding one to this counter causes the total to change to 10000.

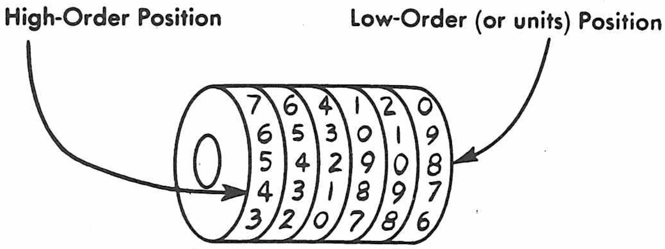


Figure 1d. Counter positions.

4. In our discussion of counters and addition we will refer to a counter using the terms high-order position and low-order position. The low-order position of a counter is its units position. The high-order position of a counter is its left-most position. If you recall, we used these terms when we described "card fields" in earlier lessons. Figure 1d illustrates a six-position counter with high-order and low-order positions indicated.

The 402 contains a maximum of 16 counter groups which all told contain 80 counter wheels. Each counter is assigned a number and a letter. The number indicates how many counter wheels are in the counter. The letter is used to merely identify the particular counter. Figure 2 illustrates the designations of all our counter groups.

2A	4A	6A	8A
2B	4B	6B	8B
2C	4C	6C	8C
2D	4D	6D	8D

Figure 2. Counter groups.

Addition in the 402 is accomplished very much like addition in a typical adding machine. Figure 3-6 illustrate how adding is accomplished in an adding machine. There are four required steps. First, information is entered into the machine by depressing the proper key (see Figure 3); then, the machine is told to add by pulling the handle down (Figure 4); at the time the machine adds, the information being added is printed (Figure 5); finally, the total is printed by depressing the total key and pulling the handle (Figure 6).

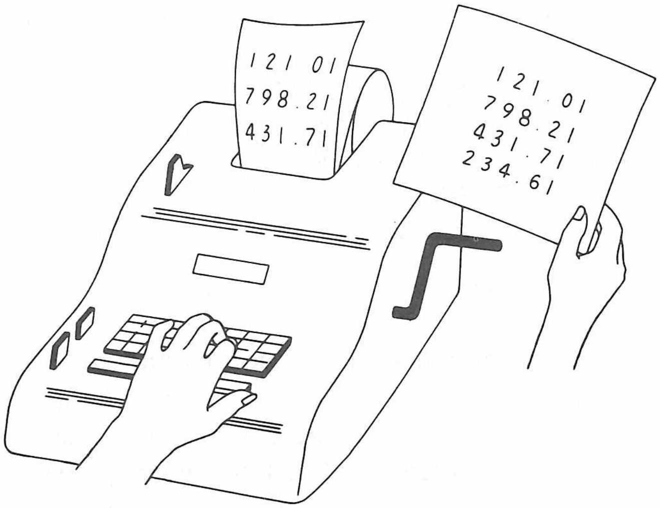


Figure 3. Reading.

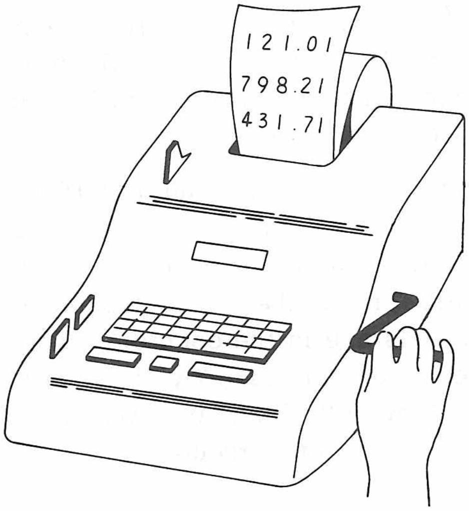


Figure 4. Adding.

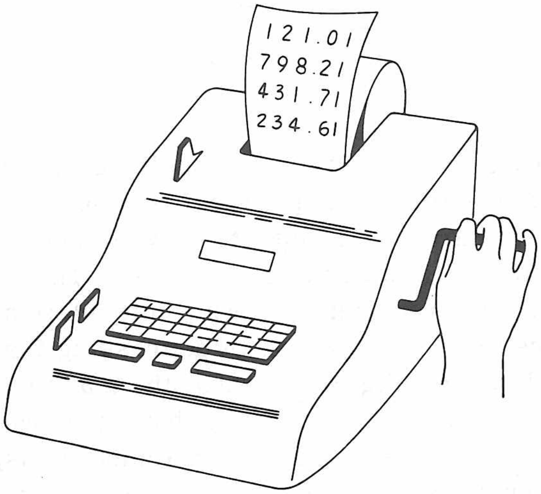


Figure 5. Printing.

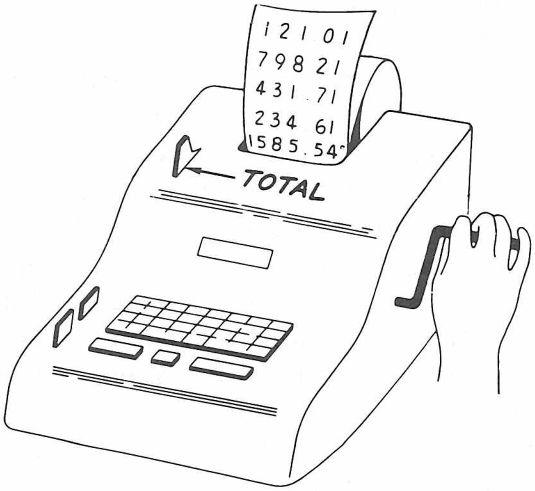


Figure 6. Getting a total.

Let us take our four basic add functions and see how they are accomplished in the 402.

1. Information must first enter the counter. This is accomplished by wiring the field to be added (from third reading) into the selected counter group. See Figure 7.

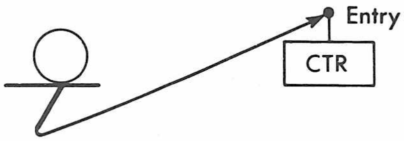


Figure 7. Information enters a counter.

2. The counter must be told to add. This is accomplished by wiring an add impulse into a counter plus hub. Each counter group has a plus hub. See Figure 8.

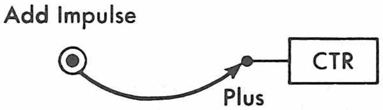


Figure 8. The counter is told to add.

3. To cause the information which is adding in the counter to print, we wire from the counter exit hubs of the counter being used to selected typebars. See Figure 9.

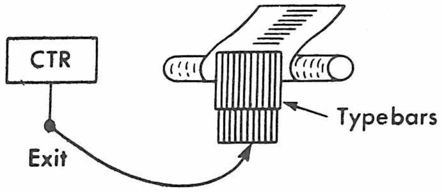


Figure 9. Information being added is printed.

4. The fourth and final step is to cause our total to print. The 402 will manufacture an impulse which is wired to the counter total hubs of the counter being used. The total will come out of the counter exits hubs and print in the selected typebars. See Figure 10. At the same time, the counter group will be restored to zero.

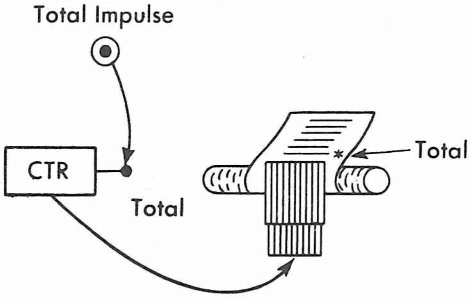


Figure 10. The total is printed.

The first step in addition is to wire the field to be added into a selected counter group. Note that you can select any counter group to accumulate your cards provided that the group is large enough to accommodate your maximum total. For example, if you are accumulating a sum which you expect may be a maximum of six digits (999999), you would use any of the six or eight position counters. You would not use a four or a two position counter as it would not be large enough to hold your total.

When placing your information into the counter, the units position of the field being added enters the units position of the selected counter, the tens position of the field enters the tens position of the counter, etc. Some of the high order positions of the counter may not be wired from third reading. These are used to contain the high order positions of the total being accumulated. See Figures 11 and 12.

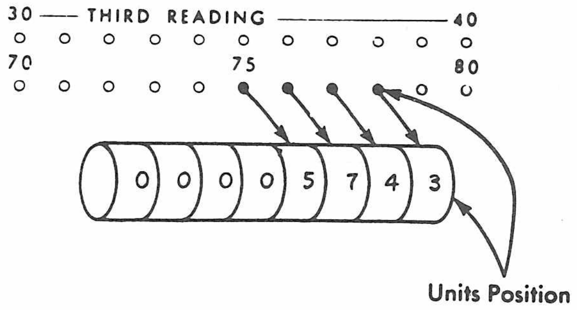


Figure 11. A card field is read by the third reading brushes into the counter.

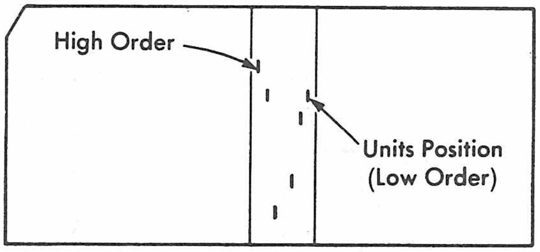
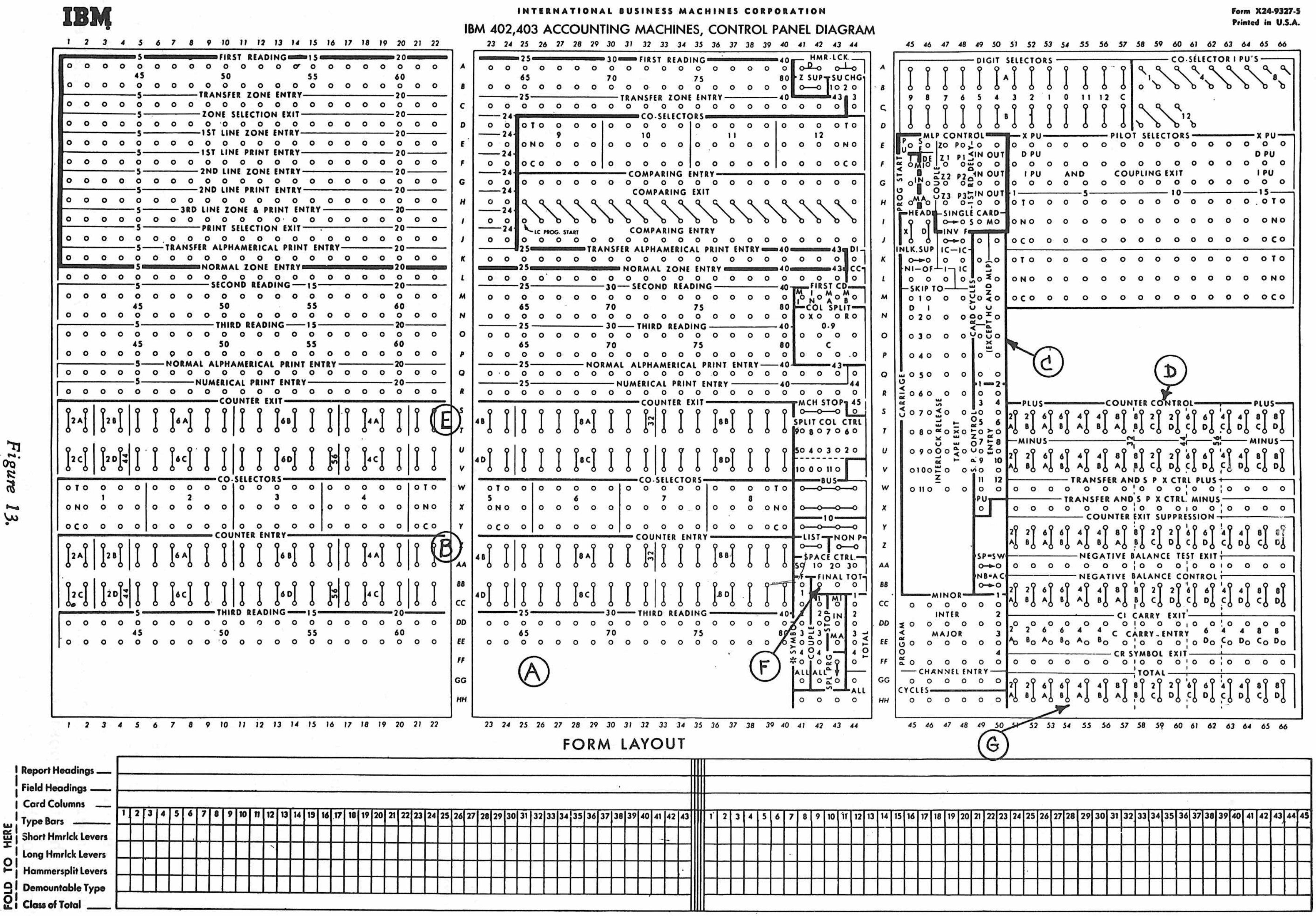


Figure 12. Positions in a card field.

Let us refer to Figure 13, our 402 diagram, and examine those hubs which are used as part of our add operation.

A) The 402 has two sets of hubs which are exits from the third reading brushes. The first set (0-P, 1-40) was used in our listing operation. The other set (DD-EE, 1-40) is used in our add operation. Note that this use is merely for convenience. Either set of third reading hubs can be used for listing or adding. Our first step in an add operation is to enter information from our cards into our selected counters. The formation to be added is read from the cards at the time they are passing under the third reading brushes.

B) Information enters the counters through the hubs called "counter entry." These hubs are located on the diagram at Z-CC, 1-40. Note that each counter group carries its designating number and letter. There are two common entry hubs for each position of the counter.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2ND LINE ZONE ENTRY
2ND LINE PRINT ENTRY
3RD LINE ZONE & PRINT ENTRY
PRINT SELECTION EXIT
TRANSFER ALPHAMERICAL PRINT ENTRY
NORMAL ZONE ENTRY
SECOND READING
THIRD READING
NORMAL ALPHAMERICAL PRINT ENTRY
NUMERICAL PRINT ENTRY
COUNTER EXIT
CO-SELECTORS
COUNTER ENTRY
COMPARING ENTRY
COMPARING EXIT
LC PROG. START
HMR. LCK.
Z SUP
SU CHG
FIRST CD
COL SPLIT
MCH STOP
SPLIT COL CTRL
BUS
LIST
NON P
SPACE CTRL
FINAL TOT
SYMBOL
COUPLE
STOP
SPL PRG
ALL
TOTAL
DIGIT SELECTORS
CO-SELECTOR I PU'S
MLP CONTROL
PROG START
COUPLE
HEAD
SINGLE CARD
INV F
INLK. SUP
SKIP TO
X PU
D PU
I PU
AND
PILOT SELECTORS
COUPLING EXIT
CARD CYCLES
(EXCEPT HC AND MLP)
CARRIAGE
INTERLOCK RELEASE
TAPE EXIT
S. P. CONTROL ENTRY
PU
SP-SW
NB-AC
MINOR
INTER
MAJOR
PROGRAM
CHANNEL ENTRY
CYCLES
PLUS
COUNTER CONTROL
MINUS
TRANSFER AND S P X CTRL PLUS
TRANSFER AND S P X CTRL. MINUS
COUNTER EXIT SUPPRESSION
NEGATIVE BALANCE TEST EXIT
NEGATIVE BALANCE CONTROL
CI CARRY EXIT
C CARRY - ENTRY
CR SYMBOL EXIT
TOTAL
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Report Headings
Field Headings
Card Columns
Type Bars
Short Hmrlck Levers
Long Hmrlck Levers
Hammersplit Levers
Demountable Type
Class of Total
FOLD TO HERE

Figure 13.

C) The second step in an add operation is to tell the counter to add. Remember, it is not enough that information enter the counter — it must be told to add. A set of hubs called "card cycles" emit an impulse for each card that is passing through the machine. This impulse will be used to signal selected counter groups to add. Note here that there is a difference between "card cycles" and "all cycles" (HH, 41-50) which was used in our listing operation. The "all cycles" hubs emit impulses for all machine cycles — this is, when cards are being read and when totals are being printed; the "card cycles" hubs emit impulses ONLY when cards are being read — they do not emit an impulse for those machine cycles when totals are being printed.

D) Each counter group has two common counter control "plus" hubs, (S-T, 51-66). Counter control plus is normally wired from card cycles to cause those counters which are impulsed to add the data entering their counter entry hubs.

E) When a counter is adding, the information which enters the counter entry hubs will be available out of that counter's exit hubs and when wired to selected typebars, will print. Counter exit hubs on the diagram are at S-V, 1-40.

F) The hubs labelled "final total," (BB, 42-44 emit impulses when the final total key (located near the start and stop keys) is pressed. This impulse is used to cause the total, which is standing in the counter, to print.

G) Each counter has two common "total" hubs (GG-HH, 51-66.) When the counter's total hub receives an impulse that counter is "cleared," that is, the amount standing in the counter is emitted through the counter's exit hubs and the counter is reset to zeroes. One way of clearing a counter is to wire the final total impulse to the selected counter's total hub, and then press the total key. A total of this type is called a "manual total" since the machine requires the operator's assistance to cause the total to print. We will soon discuss the method whereby we can obtain automatic totals without operator intervention.

Sample Problem:

We have an amount field which is punched in c.c. 2-6. We are to add all cards, list each card as it is being added and print the total of all cards in numeric t.b. 6-11. We have selected counter 6A as the counter to add these cards although we could have used any six or eight position counter. Since we want to list each card, this would be called a detail printed report. Should we only have wanted the total of these cards, the report would be called a "tabulation." This operation will be covered in the next lesson. Figure 14 presents the solution to this problem.

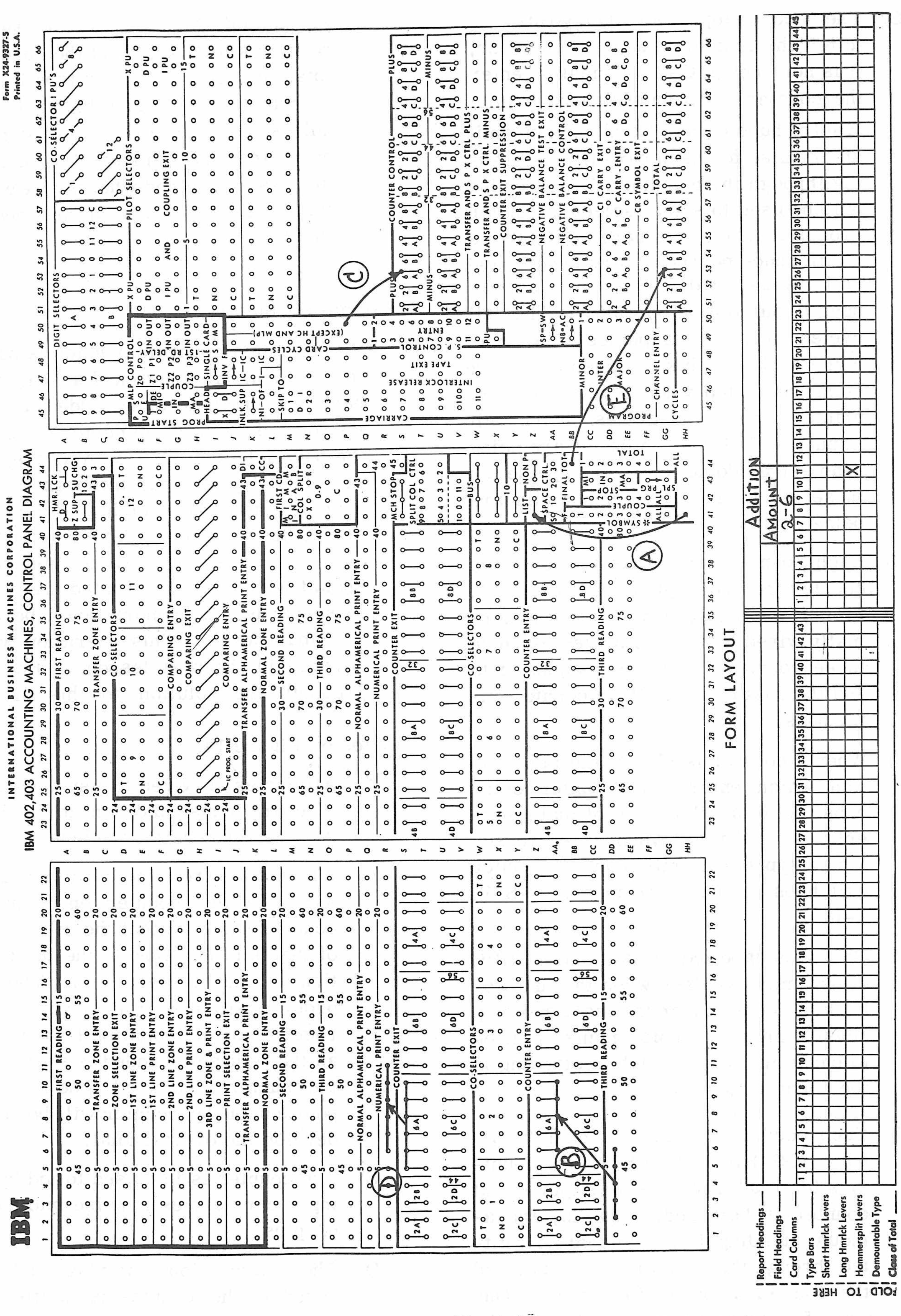
Notes on Figure 14:

A) All cycles is wired to list to cause the typebars to rise and print for each card passing through the machine.

B) Information from the card (c.c. 2-6) is wired to the counter entry hubs of counter 6A. Note that the units position of the field is wired to the units position of the counter, etc. The high-order position of 6A is not wired to receive any information from the card as the field being added is shorter than the counter being used. The high order position of the counter will be used to develop the overall total.

C) The counter is impulsed to add by wiring a card cycles impulse into counter 6A plus.

D) The information entering and being added in the counter is emitted from the counter exit hubs and will print in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COUNTER CONTROL
CO-SELECTORS
PILOT SELECTORS
DIGIT SELECTORS
FINAL TOTAL
A
B
C
D
E
FORM LAYOUT
Addition
Amount
2-6
X
Report Headings
Field Headings
Card Columns
Type Bars
Short Hmrlck Levers
Long Hmrlck Levers
Hammersplit Levers
Demountable Type
Class of Total
FOLD TO HERE

Figure 14

numeric t.b. 6-11. Note that the information printing at this time is exactly what was in the card. It is not a total or a partial total.

E) The counter is cleared by wiring a final total impulse into 6A counter total hub. The total standing in the counter at this time will be emitted from the counter exit hubs and will print in numeric t.b. 6-11. The counter will be reset to zeroes.

Exercise: Diagram the following exercise on the blank control panel diagrams provided. Check your solution with the school solution.

1. Detail print a report which will add c.c. 27-30 into counter 6A, and c.c. 71-75 into counter 6B.

   Print the total from 6A in numeric t.b. 1-6; the total from 6B in numeric t.b. 8-13.

   Clear the counters using the final total impulse.

   Indicate the hammersplits to be raised.

Practice Problem:

Detail print the report illustrated in Figure 15 using cards such as the one shown in Figure 16. The required control panel diagram is shown in Figure 17.

Notes on Figure 17:

A) All cycles is wired to list.

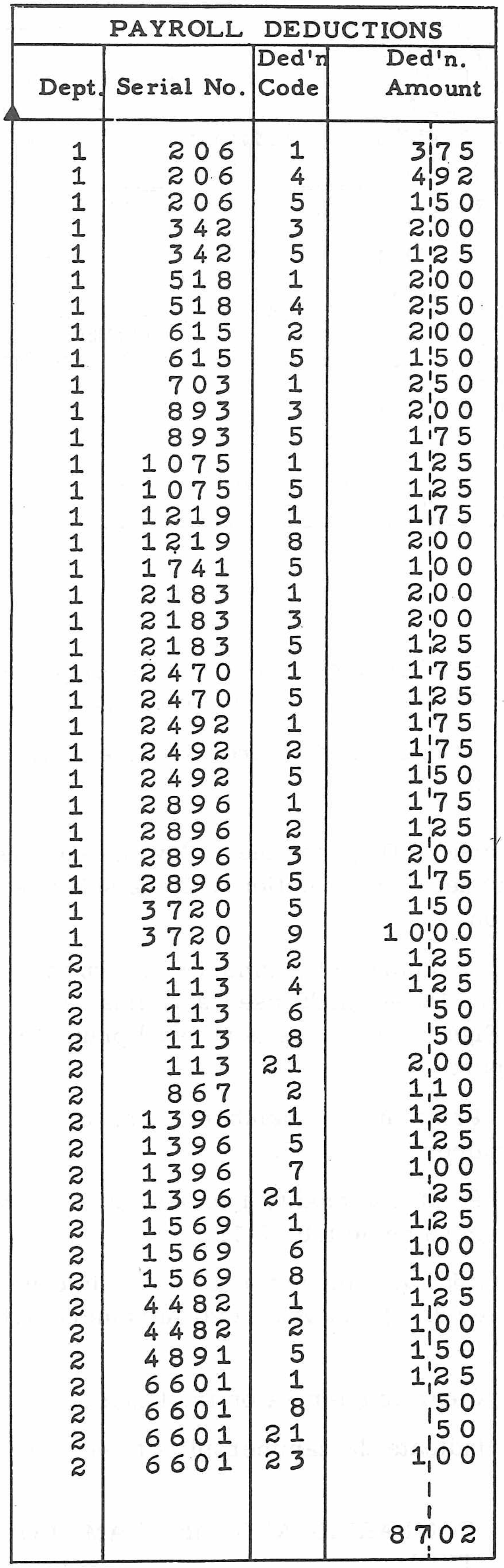
B) Dept. No., c.c. 14-16 is wired to print in numeric t.b. 1-3.

C) Serial No., c.c. 17-21 is wired to print in numeric t.b. 5-9.

D) Ded'n code, c.c. 22-23 is wired to print in numeric t.b. 11-12.

E) Ded'n amount enters counter 6C.

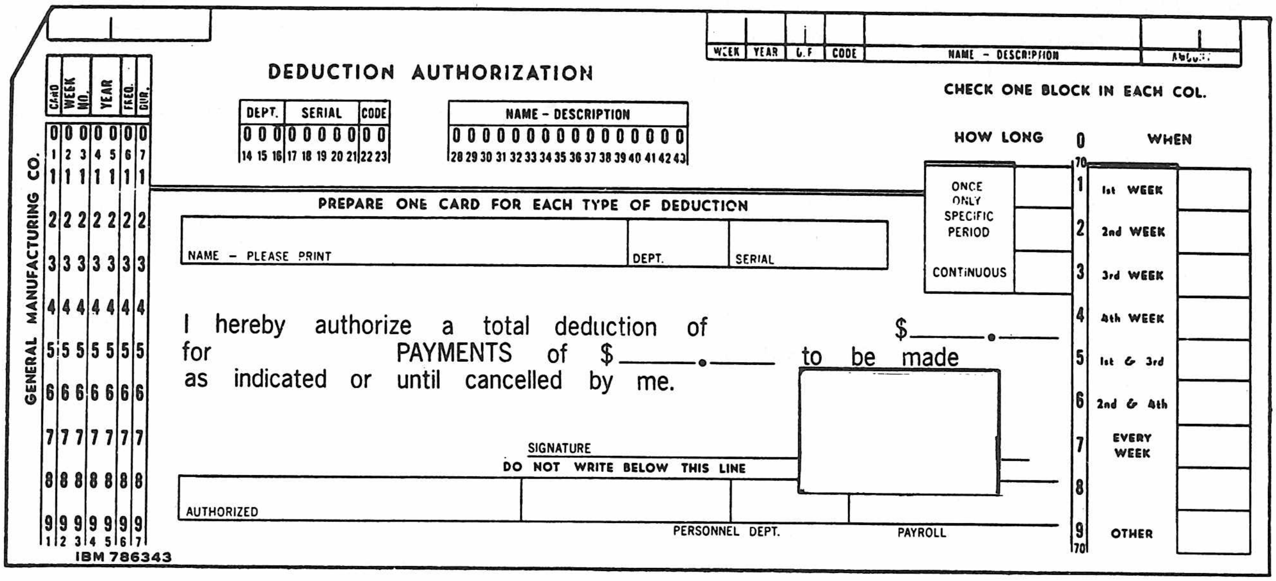
F) The amount being added prints in numeric t.b. 14-19.



PAYROLL DEDUCTIONS

Dept.	Serial No.	Ded'n Code	Ded'n. Amount
1	206	1	3 75
1	206	4	4 92
1	206	5	1 50
1	342	3	2 00
1	342	5	1 25
1	518	1	2 00
1	518	4	2 50
1	615	2	2 00
1	615	5	1 50
1	703	1	2 50
1	893	3	2 00
1	893	5	1 75
1	1075	1	1 25
1	1075	5	1 25
1	1219	1	1 75
1	1219	8	2 00
1	1741	5	1 00
1	2183	1	2 00
1	2183	3	2 00
1	2183	5	1 25
1	2470	1	1 75
1	2470	5	1 25
1	2492	1	1 75
1	2492	2	1 75
1	2492	5	1 50
1	2896	1	1 75
1	2896	2	1 25
1	2896	3	2 00
1	2896	5	1 75
1	3720	5	1 50
1	3720	9	10 00
2	113	2	1 25
2	113	4	1 25
2	113	6	50
2	113	8	50
2	113	21	2 00
2	867	2	1 10
2	1396	1	1 25
2	1396	5	1 25
2	1396	7	1 00
2	1396	21	25
2	1569	1	1 25
2	1569	6	1 00
2	1569	8	1 00
2	4482	1	1 25
2	4482	2	1 00
2	4891	5	1 50
2	6601	1	1 25
2	6601	8	50
2	6601	21	50
2	6601	23	1 00
			87 02

Figure 15.


GENERAL MANUFACTURING CO.

DEDUCTION AUTHORIZATION

CARD | WEEK NO. | YEAR | FREQ. | DUR.

DEPT. | SERIAL | CODE | NAME - DESCRIPTION

WEEK | YEAR | C.F | CODE | NAME - DESCRIPTION | AMOUNT

CHECK ONE BLOCK IN EACH COL.

HOW LONG

ONCE ONLY SPECIFIC PERIOD

CONTINUOUS

WHEN

1st WEEK

2nd WEEK

3rd WEEK

4th WEEK

1st & 3rd

2nd & 4th

EVERY WEEK

OTHER

PREPARE ONE CARD FOR EACH TYPE OF DEDUCTION

NAME - PLEASE PRINT | DEPT. | SERIAL

I hereby authorize a total deduction of $____.____ for PAYMENTS of $____.____ to be made as indicated or until cancelled by me.

SIGNATURE

DO NOT WRITE BELOW THIS LINE

AUTHORIZED | PERSONNEL DEPT. | PAYROLL

IBM 786343

Figure 16.

G) Card cycles is wired to counter plus of 6C to cause it to add all cards.

H) Counter 6C is cleared with the final total key.

Exercise: Diagram the following exercise and check your solution with the school solution.

2. The report to be printed is shown in Figure 18 — cards used are illustrated in Figure 19. This is a detail printed report.

A) Print invoice number, c.c. 34-38 in numeric t.b. 1-5.

B) Print commodity number, c.c. 62-66 in numeric t.b. 7-11.

C) Add item amount, c.c. 67-73 in counter 8A; print your total in numeric t.b. 13-20.

D) Clear counter 8A on final total.

E) Indicate the hammersplits to be raised.

14.2 COMPARING AND PROGRAM CONTROL.

The problems we have discussed so far in this lesson were those in which we were concerned about accumulating a total for a complete file of cards. This type of situation is the exception rather than the rule. In most instances, we are given a file of cards which have been sorted or collated into some desired sequence and we are required to accumulate totals for many various groups which are in the file. For example, we would have a file of cards which are sorted into sequence by department number (see Figure 15) and we would want to list these cards and print totals by department rather than an overall total.

We could accomplish this objective (get totals by department) merely by placing the cards for each department in the tabulator separately and after each department has listed, we would press the final total key. However, if we had hundreds or thousands of departments in our file, this would be a laborious task. Again, we are going to ask the machine to do this work for us.

In order for the tabulator to print totals after each department has listed, it must have the ability to tell when it has printed the last card of one department and is about to print the first card of the next department. The tabulator can do this by making use of a function we are all familiar with — the function of "comparing." I.B.M. machines can compare two cards and tell whether they are

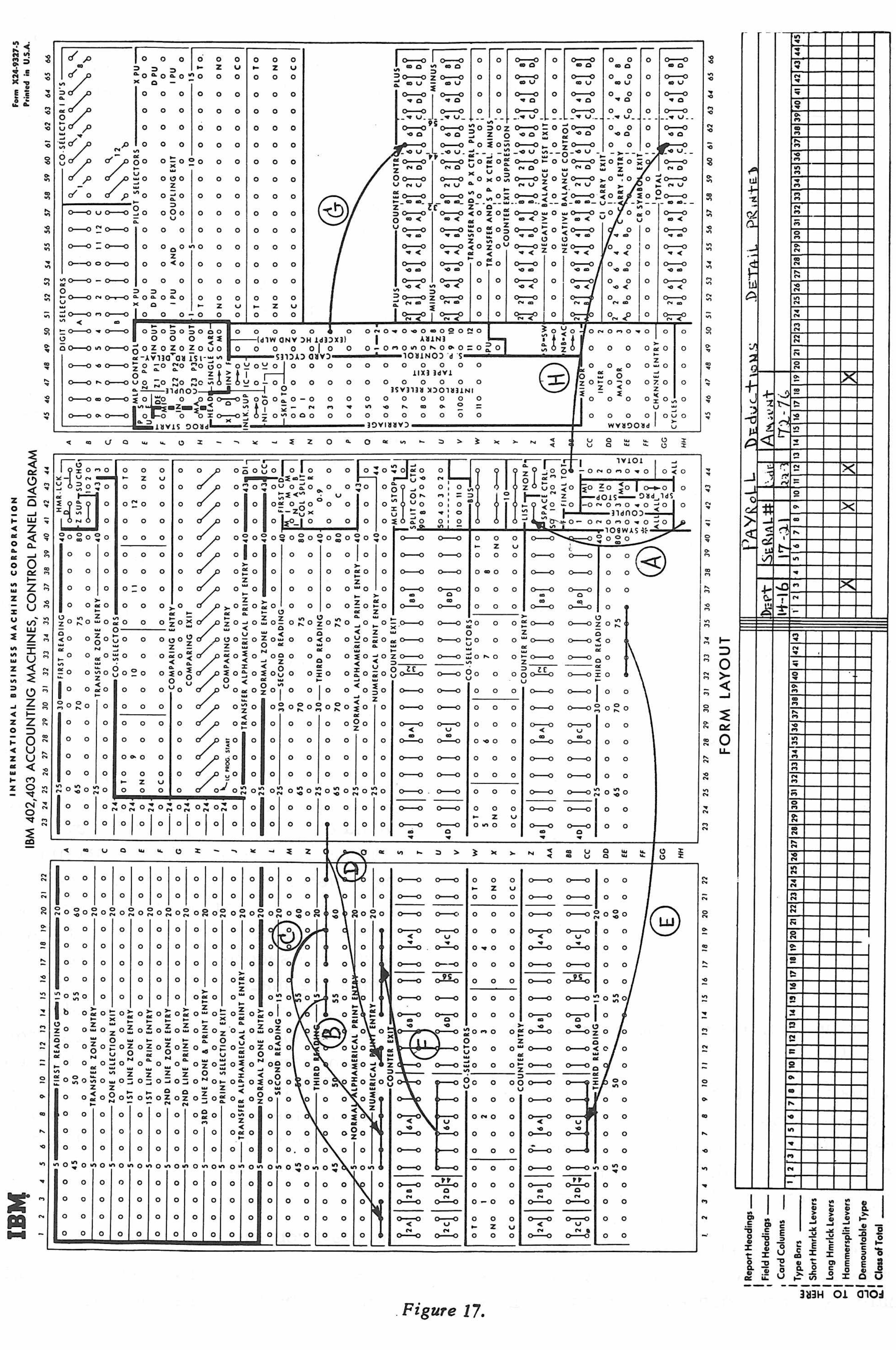

IBM
INTERNATIONAL BUSINESS MACHINES CORPORATION
IBM 402,403 ACCOUNTING MACHINES, CONTROL PANEL DIAGRAM
Form X24-9327-5
Printed in U.S.A.
FIRST READING
TRANSFER ZONE ENTRY
ZONE SELECTION EXIT
CO-SELECTORS
COMPARING ENTRY
COMPARING EXIT
TRANSFER ALPHAMERICAL PRINT ENTRY
NORMAL ZONE ENTRY
SECOND READING
THIRD READING
NORMAL ALPHAMERICAL PRINT ENTRY
NUMERICAL PRINT ENTRY
COUNTER EXIT
COUNTER ENTRY
DIGIT SELECTORS
PILOT SELECTORS
COUPLING EXIT
CARD CYCLES
COUNTER CONTROL
TRANSFER AND S P X CTRL PLUS
TRANSFER AND S P X CTRL MINUS
COUNTER EXIT SUPPRESSION
NEGATIVE BALANCE TEST EXIT
NEGATIVE BALANCE CONTROL
CI CARRY EXIT
CARRY ENTRY
CR SYMBOL EXIT
TOTAL
PROGRAM
MINOR
INTER
MAJOR
CHANNEL ENTRY
CYCLES
FINAL TOT
SPACE CTRL
A
B
C
D
E
F
G
H
FORM LAYOUT
Report Headings
Field Headings
Card Columns
Type Bars
Short Hmrlck Levers
Long Hmrlck Levers
Hammersplit Levers
Demountable Type
Class of Total
FOLD TO HERE
PAYROLL Deductions DETAIL PRINTED
Dept
SERIAL #
Amount
14-16
17-21
72-76
X
X
X
X

Figure 17.

PROOF LIST - SALES CARDS		
Invoice Number	Commodity Number	Item Amount
12183	13102	63 00
12184	11202	33 20
12184	23303	6 12
12184	53208	19 40
12185	32104	123 30
12185	42106	241 50
12185	62109	145 00
12187	16102	15 30
12187	21103	44 25
12187	21502	27 75
12187	44104	14 04
12197	33204	123 75
12197	54107	99 60
12198	14202	13 20
12198	14203	24 00
12198	14206	161 00
12198	16103	4 92
12198	21103	8 85
12198	31104	114 75
12198	33202	97 65
12198	32105	5 28
12199	62110	217 50
12200	14702	27 00
12203	13102	37 80
12203	14202	3 52
12203	31703	106 80
12203	32104	10 96
12203	35104	41 40
12203	44105	171 45
12204	11202	12 45
12204	13102	21 00
12204	14202	13 20
12204	16103	41 00
12204	16103	41 00
12204	23103	29 40
12204	32105	118 80
12204	62110	217 50
		2496 64

Figure 18.

equal or unequal (as can the reproducer or the collator.)

Let us refer to Figure 20. The 402 tabulator has 20 comparing magnets. Remember, the reproducer had 45 standard magnets (35 more optional) and the collator has 16 comparing magnets. Each comparing magnet has two entry hubs called upper (G, 25-44) and lower (J, 25-44). Also, each comparing magnet has two common exit hubs, diagonally arranged between the entry hubs (H-I, 25-44.) Comparing magnet 20 has but one exit hub. The upper portion of the comparing exit hubs indicate the comparing magnet they belong to. For example, the exit hubs for comparing magnet 1 are those hubs found at H-25 and I-26.

Should the information entering the upper comparing magnet entry be different than the information entering the lower comparing magnet entry the corresponding comparing magnet exits will emit impulses (called unequal impulses.) This unequal impulse is wired to one of the program start hubs (F-H, 45). There are three program start hubs: (1) Minor, (2) Intermediate, (3) Major. When one of the program start hubs receives an impulse, it activates its corresponding total program exit hubs (CC-FF, 44-50).

For example, should the minor program start hub receive an impulse, it would activate the minor total program exit hubs (CC-FF, 44-50). They would all emit impulses. Normally, a total program exit impulse is wired to a counter total hub to cause the counter to read out and print a total. This type of total would be known as an automatic total.

One more point before we discuss a problem which will illustrate comparing and program control. As cards pass through the tabulator, they first are read by the second reading brushes and then by the third reading brushes. At any time, except for the first and last card of the file, there are two cards being read by the 402. By wiring a field from second reading to one half of the comparing magnets and from third reading to the other half of the correspondingly numbered comparing magnets, we can compare the two cards to see if the fields are the same or if they are different. Should they be different, the comparing exit hubs would emit an impulse which could be used to print our accumulated total. See Figure 21.

Sample Problem:

Our file of cards has been sorted into sequence by department number, c.c. 7-9.

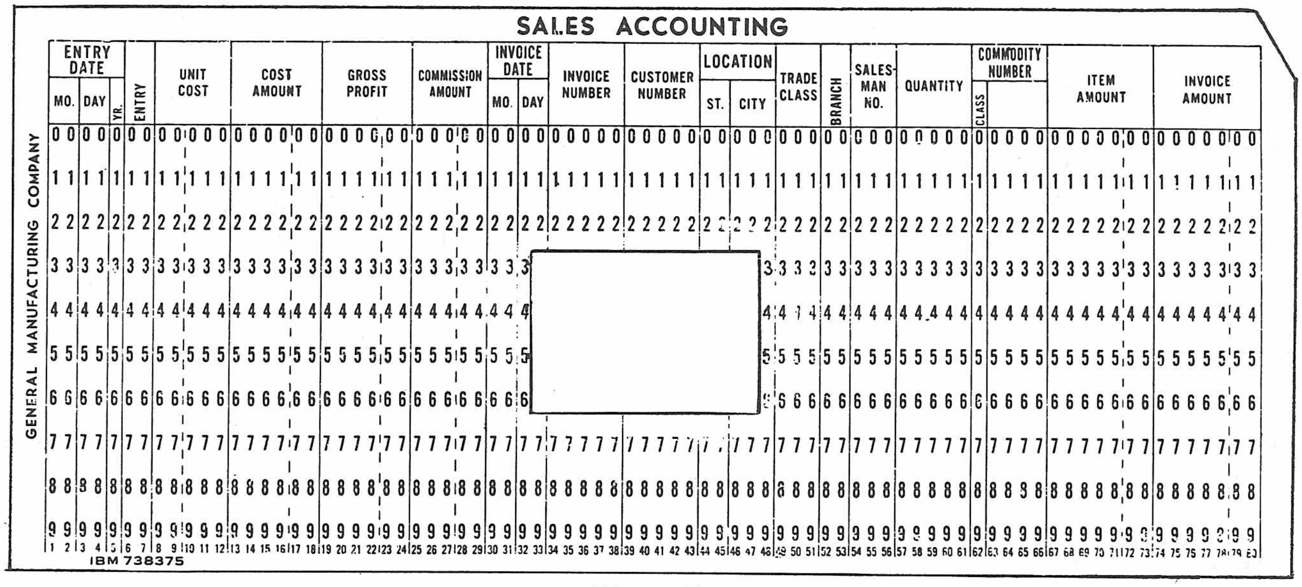


Figure 19.

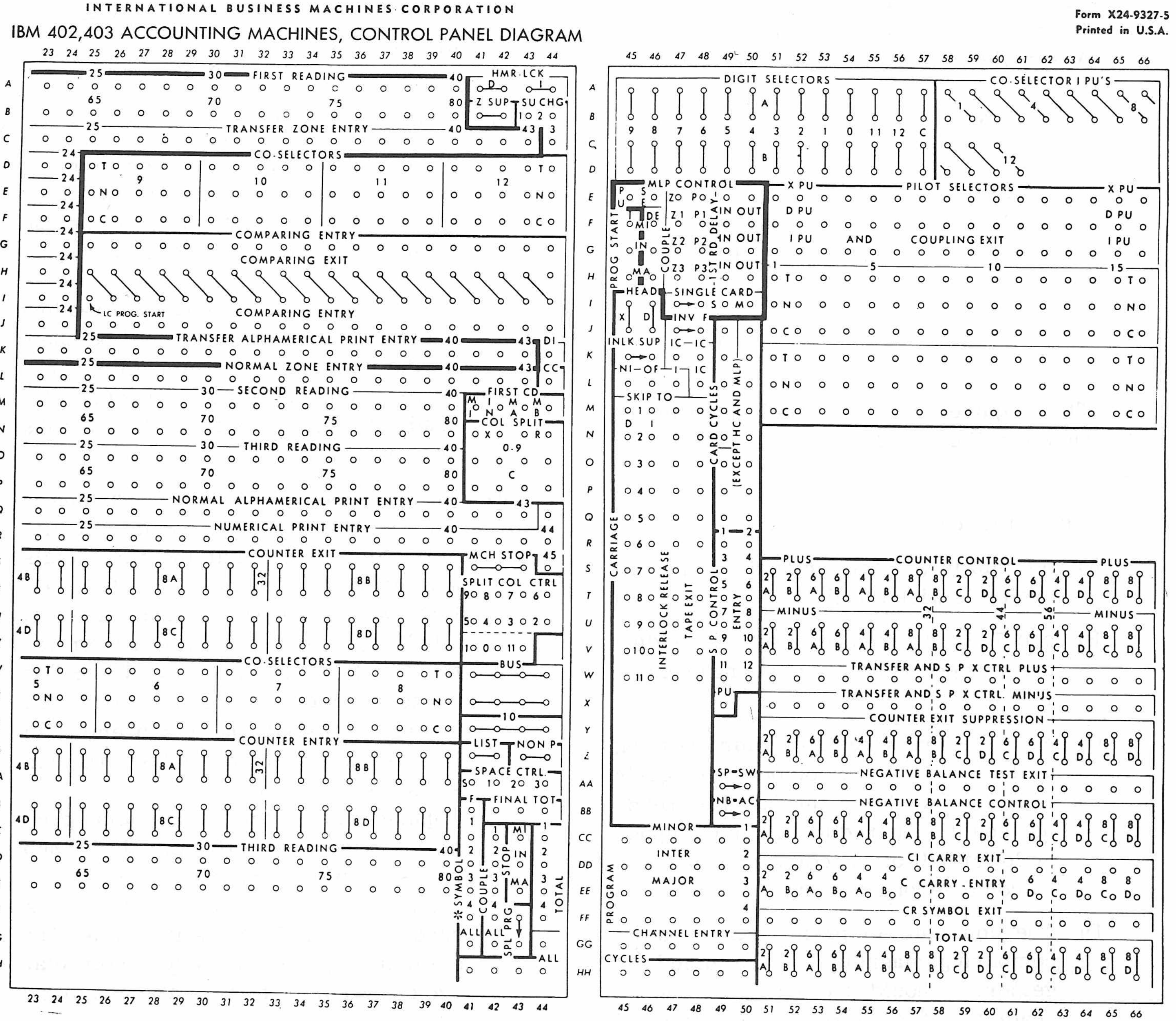


Figure 20.

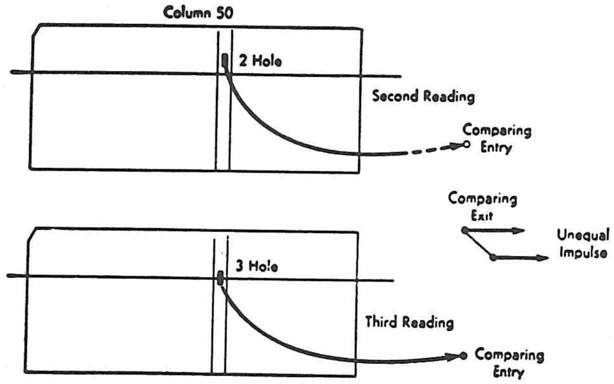


Figure 21. Comparing.

We are to detail print a report with totals by department. To identify the total, we have decided to print an asterisk symbol (*) immediately to the right of each total. A sample of this report is shown below:

Dept. No.	Amount
123	657 24
123	26 50
123	457 87
	1141 61*
126	10 00
126	345 80
	355 80*

The required control panel diagram is shown in Figure 22.

Notes on Figure 22:

A) As this is a detail printed report, all cycles is wired to list.

B) c.c. 7-9 are wired from second reading to the upper half of comparing magnets 1-3.

C) c.c. 7-9 are wired from third reading to the lower half of comparing magnets 1-3. Note at this point that third reading could be wired to either the upper or lower half of the comparing magnets as could second reading.

D) The common comparing exit hubs for comparing magnets 1-3 are joined together. Should the card at second reading differ from the card at third reading (c.c. 7-9), one or more of the comparing magnets being used will emit an unequal impulse from its exit hubs. This impulse will be taken into Minor Program Start. At the end of this card cycle, card reading will stop, and the 402 will take a total cycle as the minor total program exit hubs will be activated.

E) c.c. 7-9 are wired to print in numeric t.b. 1-3.

F) c.c. 64-70 are wired to counter entry of 8A.

G) The counter exit hubs of 8A are wired to numeric t.b. 5-12 to print the information adding from the cards and all of our totals.

H) Counter 8A is wired to add all cards.

I) When a change in department number is sensed by the machine by the comparing magnets (D), an unequal impulse is sent to minor program start. This will activate the minor total program exit hubs. At this point, card reading will stop — a total cycle will be taken by the machine — counter 8A will receive an impulse which will cause it to read out its contents from its exit hubs and reset to zeroes.

J) The impulse used by the machine to cause an asterisk (*) to print is emitted by the machine at the time totals are printed. Refer to BB-GG, 41. Here we have 6 hubs. They are all labelled (* Symbol) and are further defined as F, 1, 2, 3, 4, All. The F hub emits an impulse when the final total key is depressed; the 1 hub emits an impulse when minor total program exits are activated; the 2 hub emits an impulse when intermediate total program exits are activated; the 3 hub emits an impulse when major total program exits are activated; the 4 hub is special, we will ignore it; the All hub emits an impulse for every type of total cycle: minor, intermediate, major or final.

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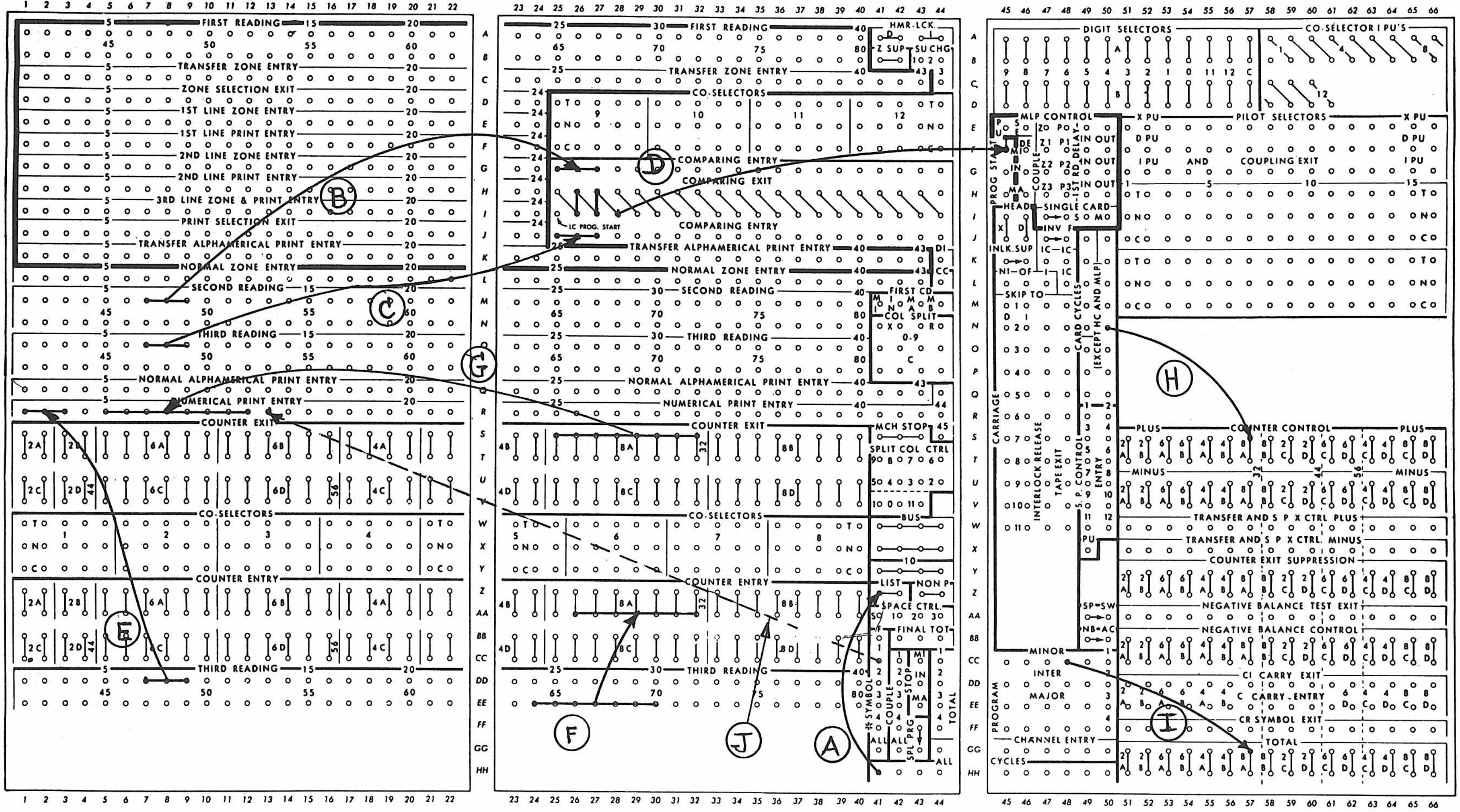


FORM LAYOUT

Report Headings — COMPARING

Field Headings — DEPT AMOUNT

Card Columns — 7-9 64-70 *

Type Bars — 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45

Short Hmrlck Levers

Long Hmrlck Levers

Hammersplit Levers — X X X

Demountable Type

Class of Total

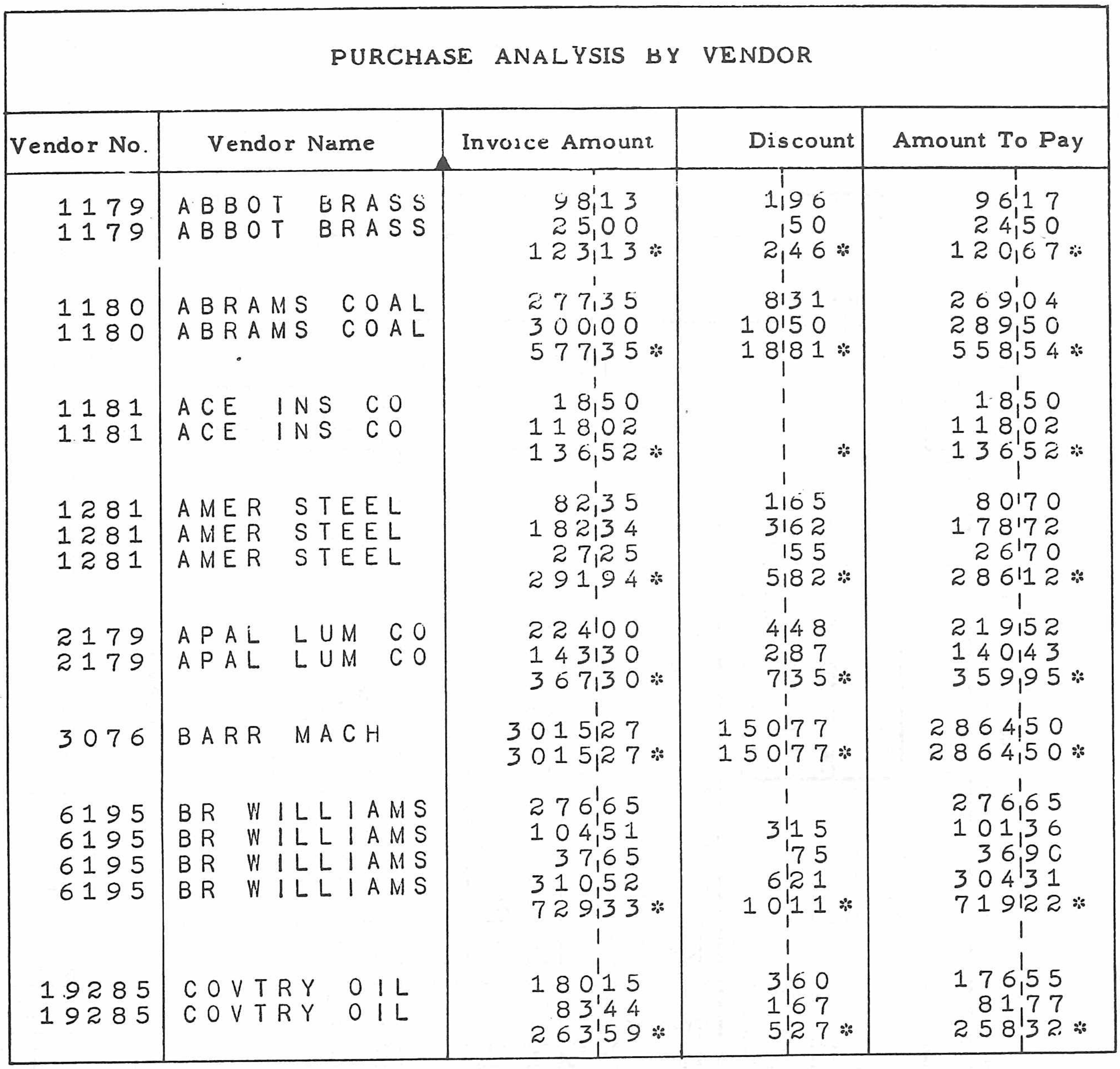
FOLD TO HERE

Figure 22.

An asterisk (*) symbol will be found in every odd-numbered numeric typebar. The even numbered numeric typebars contain a "CR" symbol. For our problem, we wire the 1 * symbol hub to numeric t.b. 13 to cause the asterisk to print. We must also raise the hammersplit lever for this typebar.

Sample Problem:

We are to prepare a detail printed report, like the one shown in Figure 23 from cards such as the sample presented in Figure 24.



PURCHASE ANALYSIS BY VENDOR

Vendor No.	Vendor Name	Invoice Amount	Discount	Amount To Pay
1179	ABBOT BRASS	9813	196	9617
1179	ABBOT BRASS	2500	50	2450
		12313 *	246 *	12067 *
1180	ABRAMS COAL	27735	831	26904
1180	ABRAMS COAL	30000	1050	28950
		57735 *	1881 *	55854 *
1181	ACE INS CO	1850		1850
1181	ACE INS CO	11802		11802
		13652 *	*	13652 *
1281	AMER STEEL	8235	165	8070
1281	AMER STEEL	18234	362	17872
1281	AMER STEEL	2725	55	2670
		29194 *	582 *	28612 *
2179	APAL LUM CO	22400	448	21952
2179	APAL LUM CO	14330	287	14043
		36730 *	735 *	35995 *
3076	BARR MACH	301527	15077	286450
		301527 *	15077 *	286450 *
6195	BR WILLIAMS	27665		27665
6195	BR WILLIAMS	10451	315	10136
6195	BR WILLIAMS	3765	75	3690
6195	BR WILLIAMS	31052	621	30431
		72933 *	1011 *	71922 *
19285	COVTRY OIL	18015	360	17655
19285	COVTRY OIL	8344	167	8177
		26359 *	527 *	25832 *

Figure 23.

Three fields are to be added — invoice amount, discount and amount to pay. We are interested in obtaining totals by vendor (vendor number is called our "control group.") Figure 25 is the required control panel diagram.

Notes on Figure 25:

A) All Cycles is wired to list.

B) Vendor number (a numeric field) is wired to print from alphamerical typebars 27-31.

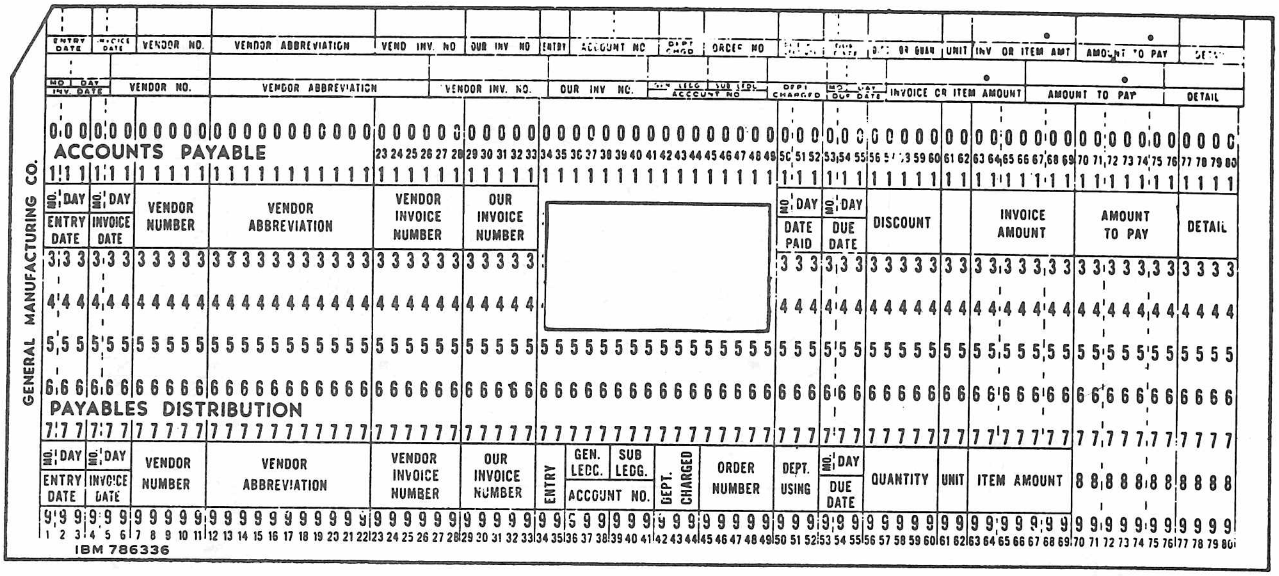


Figure 24.

C) Vendor name (an alphabetic field) is wired to print from alphamerical typebars 33-43.

D) The invoice amount is wired to add in counter 8A.

E) Discount amount is wired to add in 6B.

F) Amount to pay is wired to add in 8B.

G) All three counters are wired to add from every card.

H) The field "vendor number" is wired from second and third reading into the comparing magnets.

I) The unequal impulse is wired to minor program start.

J) When a change in vendor number is recognized, the minor total program exit hubs will emit impulses and cause counters 6B, 8A and 8B to clear.

K) Information being read from cards, and all totals, will come out of the counter exit hubs to selected typebars.

L) We are required to print asterisks in three places. The "1" hub is wired to a set of four common hubs called "bus" hubs. This same impulse is now available from all of these hubs and is wired to the selected odd-numbered typebars.

Exercise: Diagram the following exercise and then compare your solution to the school solution:

3. We are to print a "cost of sales" report as shown in Figure 26 from cards such as the one shown in Figure 27.

A) Print commodity number in alphamerical t.b. 33-37. Commodity number is our minor control group.

B) Print unit cost in alphamerical t.b. 39-43.

C) Quantity is to be added in counter 6C and printed in numeric t.b. 1-5.

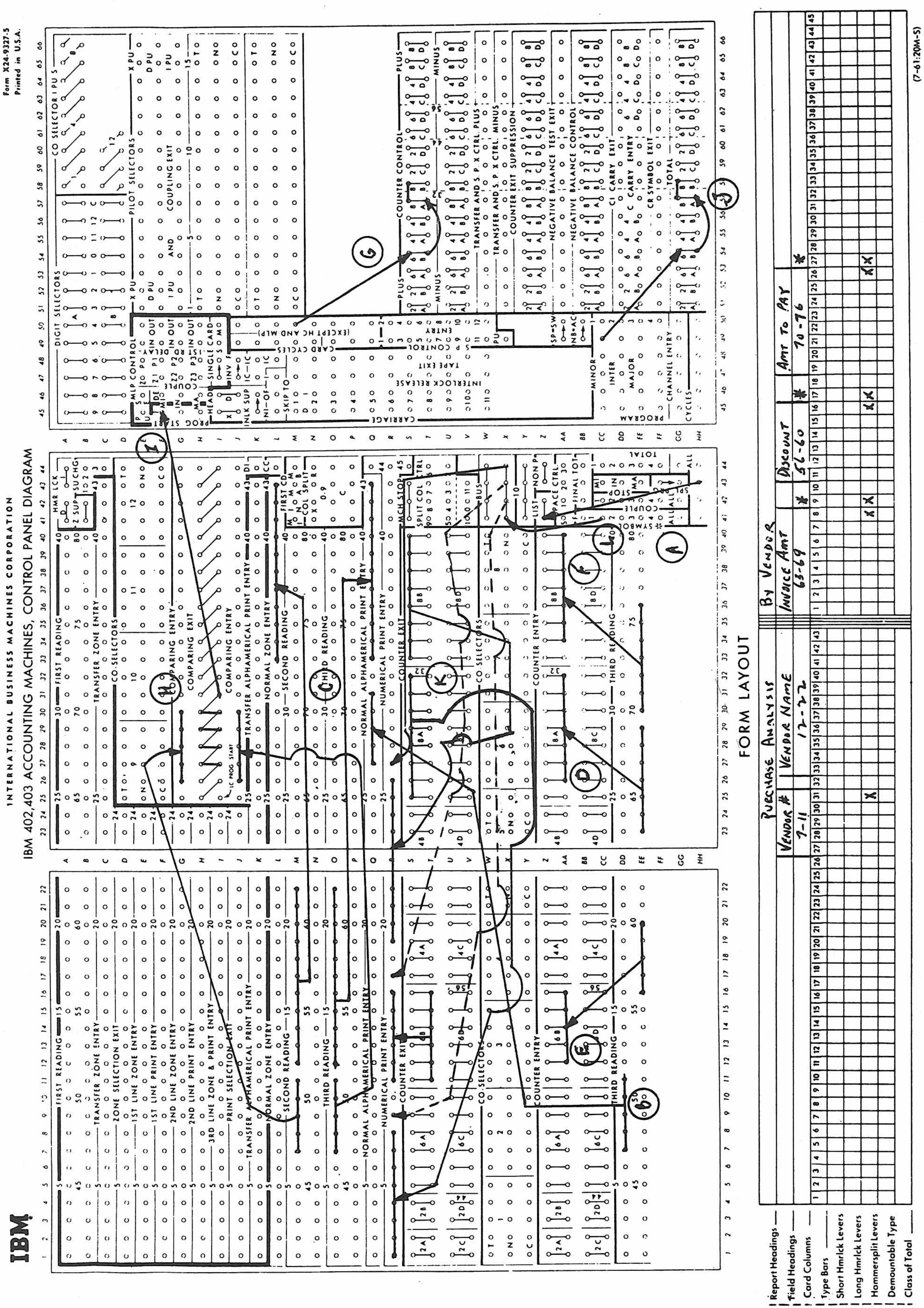
D) Sales amount is to be added in counter 8A and printed in numeric t.b. 7-13.

E) Cost amount is to be added in counter 6B and printed in numeric t.b. 17-22.

F) Gross profit is to be added in counter 8B and printed in numeric t.b. 24-29.

G) Print asterisks in numeric typebars 15 & 31.

H) Indicate the hammersplit levers to be raised.


INTERNATIONAL BUSINESS MACHINES CORPORATION
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IBM
Form X24-9327-5
Printed in U.S.A.
FORM LAYOUT
Purchase Analysis By Vendor
Vendor #
7-11
Vendor Name
12-22
Invoice Amt
63-69
Discount
56-60
Amt to Pay
70-76
Report Headings
Field Headings
Card Columns
Type Bars
Short Hmrlck Levers
Long Hmrlck Levers
Hammersplit Levers
Demountable Type
Class of Total
FOLD TO HL
(7-61:20M-5)

Figure 25.

COST OF SALES

Commodity Number	Unit Cost	Quantity	Invoice Amount #	Cost Amount	Gross Profit
11102	556	4	276	222	54
11102	556	2	138	111	27
11102	556	20	1380	1112	268
		26	1794 *	1445	349 *
11202	664	40	3320	2656	664
11202	664	15	1245	996	249
11202	664	40	3320	2656	664
11202	664	40	3320	2656	664
11202	664	3	249	199	50
11202	664	40	3320	2656	664
		178	14774 *	11819	2955 *
13102	673	75	6300	5048	1252
13102	673	45	3780	3029	751
13102	673	25	2100	1683	417
13102	673	75	6300	5048	1252
		220	18480 *	14808	3672 *
14202	709	15	1320	1064	256
14202	709	4	352	284	68
14202	709	15	1320	1064	256
14202	709	15	1320	1064	256
14202	709	30	2640	2127	513
14202	709	20	1760	1418	342
		99	8712 *	7021	1691 *
14203	768	25	2400	1920	480
14203	768	20	1920	1536	384
14203	768	30	2880	2304	576
14203	768	1	96	77	19
		76	7296 *	5837	1459 *
14702	810	25	2700	2025	675
14702	810	35	3780	2835	945

Figure 26.

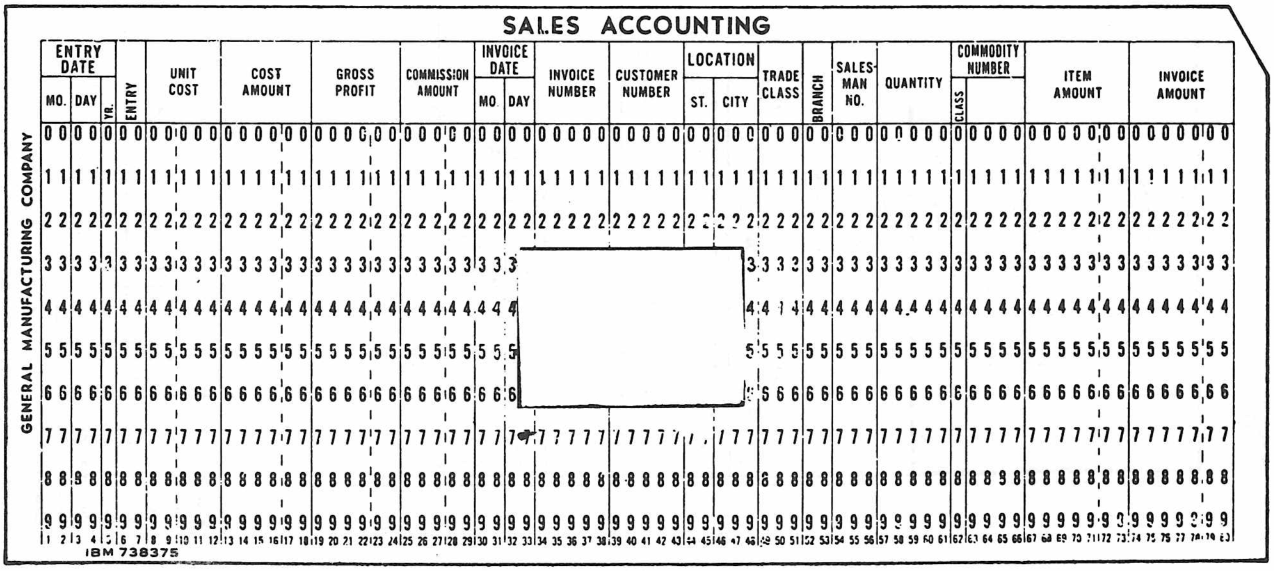
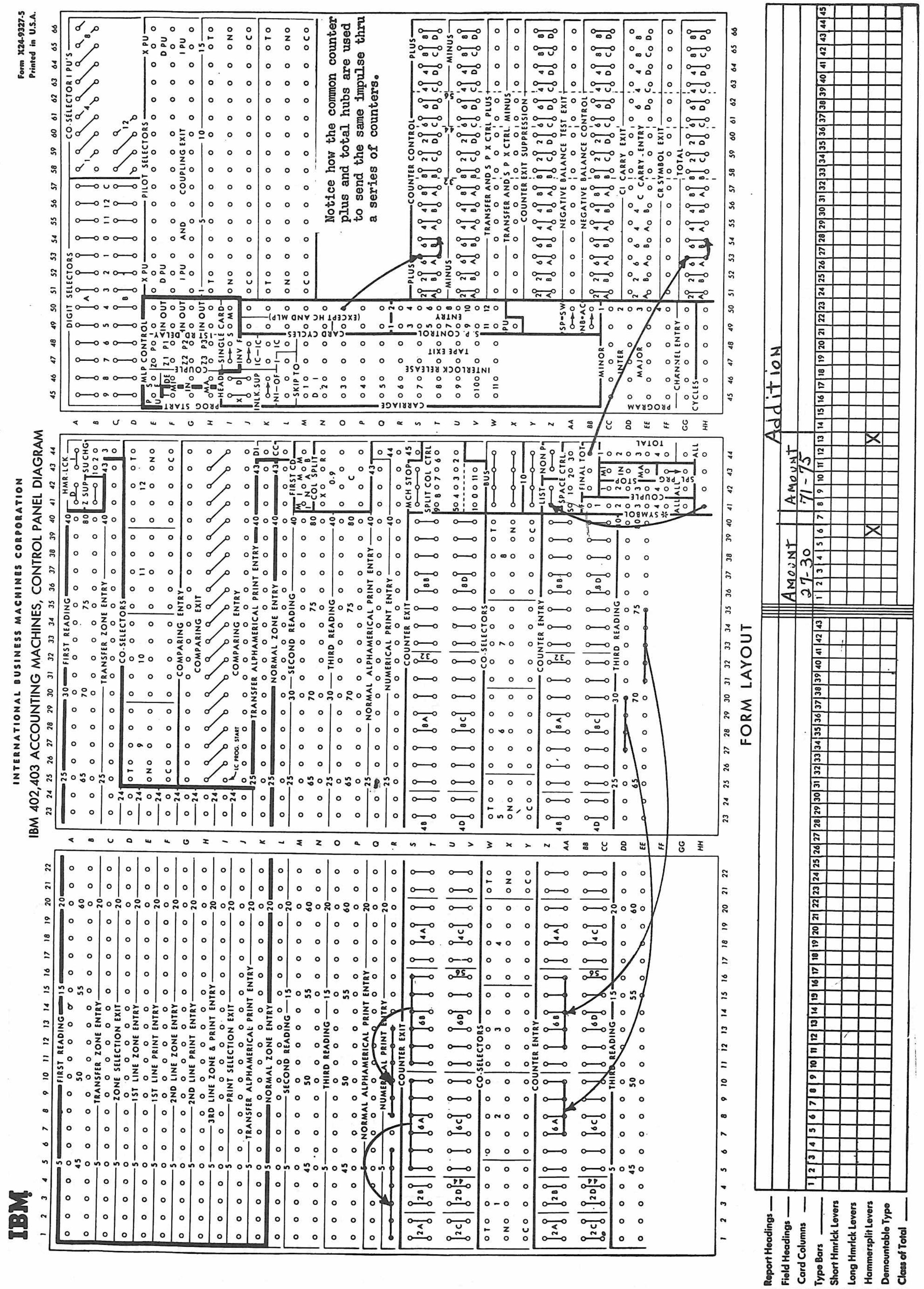
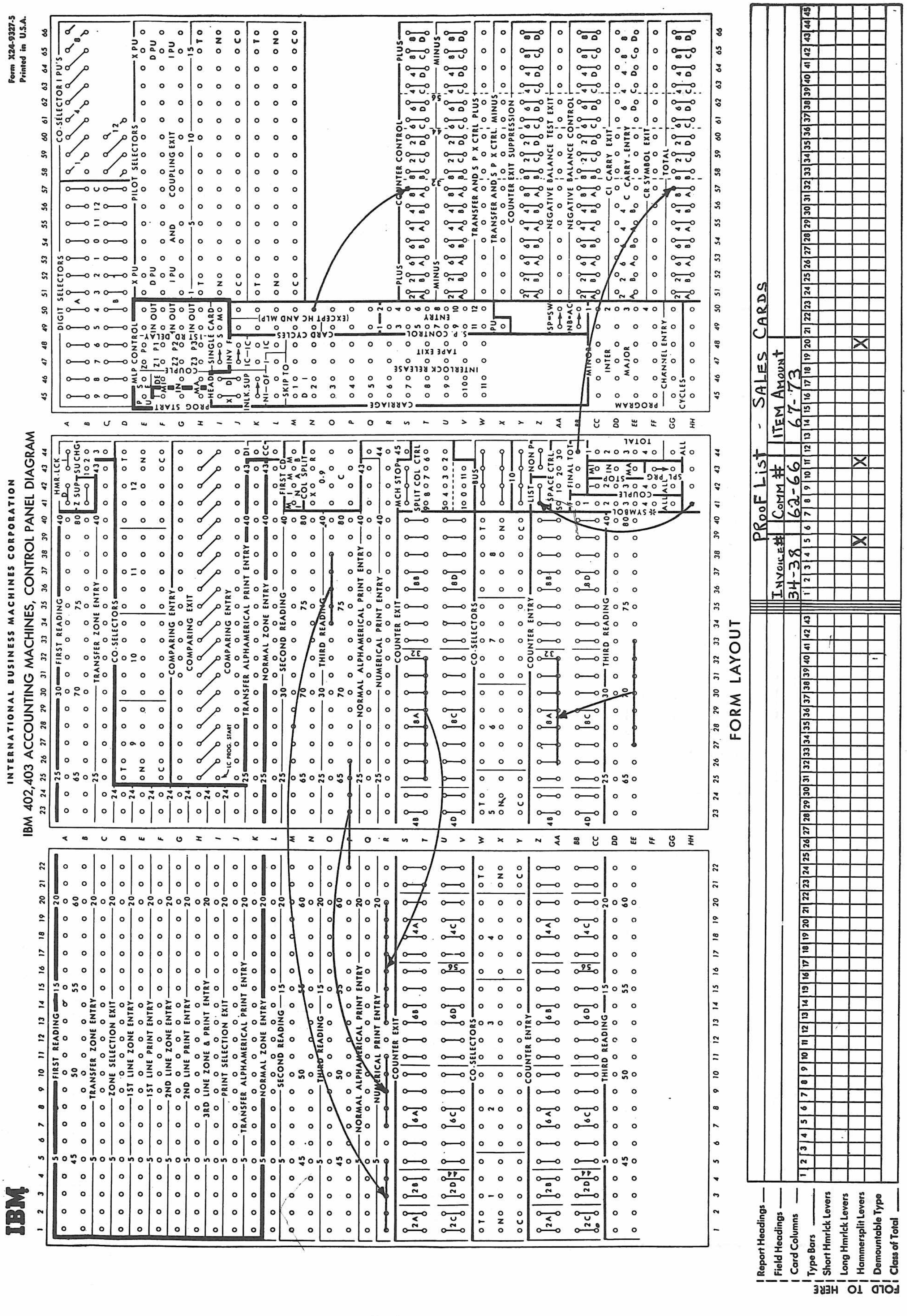


Figure 27.

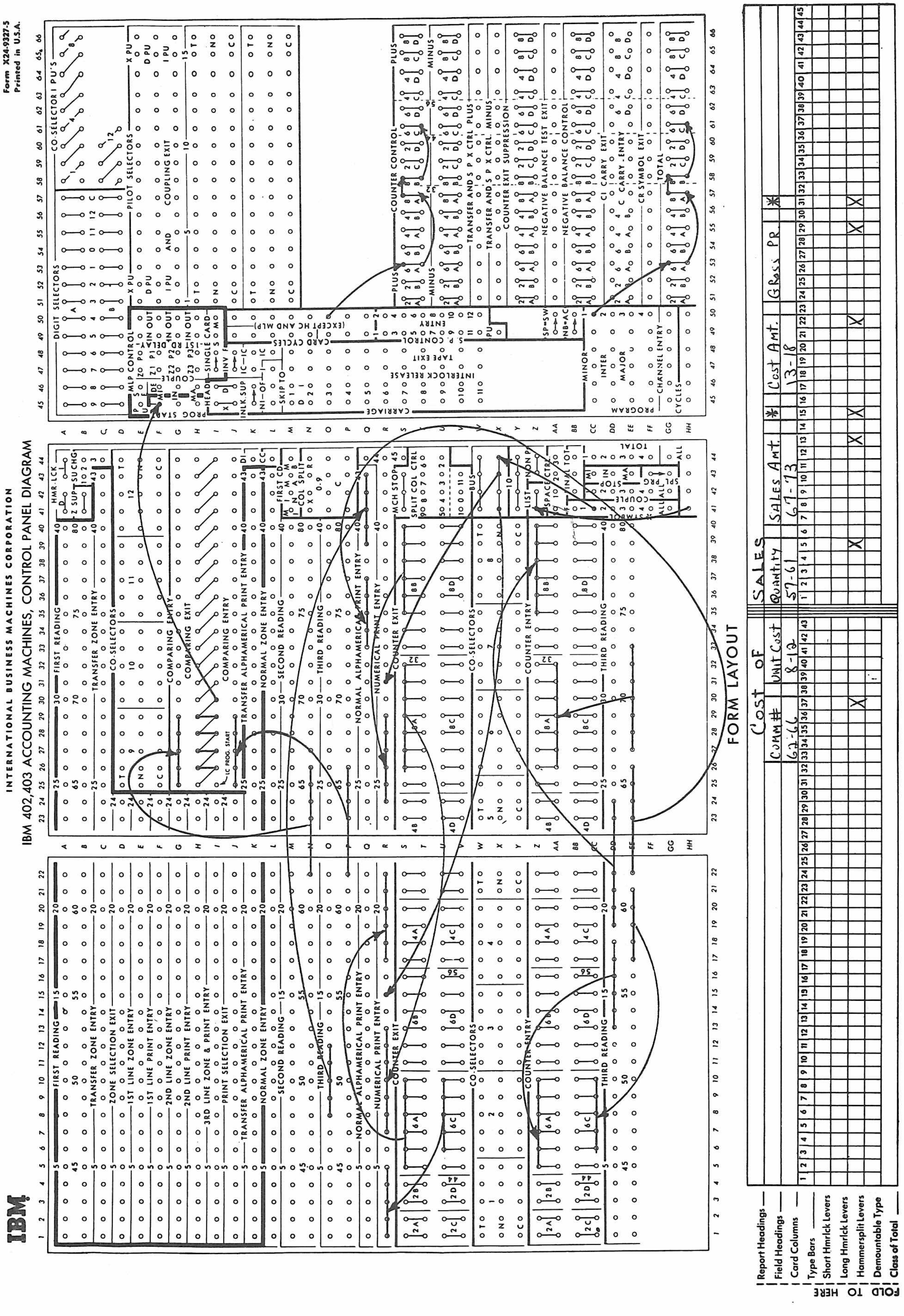


Notice how the common counter plus and total hubs are used to send the same impulse thru a series of counters.

Solution to exercise 1.



Solution to exercise 2.



Solution to exercise 3.

GLOSSARY

Asterisk (*) Symbol — this symbol is usually printed on the same line as a total merely to facilitate identifying the total line as the report is being read.

Automatic Total — a total of this type is printed when any of the three program start hubs receives an unequal impulse. This type of total is not caused by the operator but by control panel wiring to our comparing magnets.

Bus Hubs — there are two sets of four common hubs each. They are used when multiples of the same impulse are required.

Card Cycles — these hubs emit an impulse for every card being read. They do not emit at the time totals are being printed.

Carry — when the total in a counter wheel exceeds nine, a one is carried to the counter wheel at its left.

Control Group — a term used to denote the field we are comparing.

Clear — a term which means to cause a counter to emit its total and reset to zeroes.

Counter — a device consisting of a group of wheels used to accumulate information.

Counter Entry — those hubs which receive the information to be accumulated.

Counter Exits — those hubs which emit the information being accumulated and all totals.

Manual Total — a total which is printed by some action on the part of the operator (such as pressing the Final Total key).

Program Start Hubs — hubs which will accept unequal impulses to cause their corresponding total program exit hubs to become activated.

Plus Hubs — each counter has a set of plus hubs which, when impulsed, cause the counter to add the information entering the counter entry hubs.

Total Hubs — each counter has a set of total hubs which, when impulsed, cause the total standing in the counter to read out (be emitted) after which the counter is reset to zeroes.

Total Program Exit Hubs — the minor, intermediate and final total program exit hubs are activated when their corresponding program start hubs receive an unequal impulse. The final hub is activated when the operator pressed the final key. They are normally wired to counter total hubs to cause the counter to clear.

Unequal Impulse — when the comparing magnets recognize a change in the control group, an impulse is emitted from the comparing exit hubs.

EXAMINATION – LESSON 14

1. The term "low order" applies to the ________ of a counter.
   - A. left-most position
   - B. right-most position
   - C. tens position
   - D. All the above are incorrect

2. "Card cycles" emits
   - A. for every machine cycle
   - B. for total cycles only
   - C. for every card being read
   - D. when counters clear

3. Final total is sometimes called –
   - A. automatic total
   - B. manual total
   - C. counter total
   - D. total program

4. To add information –
   - A. third reading is wired to counter exit
   - B. all cycles is wired to counter plus
   - C. card cycles is wired to counter plus
   - D. third reading is wired to counter entry and card cycles is wired to counter plus

5. The total hub of a counter when impulsed will cause that counter to –
   - A. add
   - B. clear
   - C. detail print
   - D. all the above are correct

6. A seven position total can be accumulated in counter –
   - A. 6A
   - B. 4C
   - C. 8A
   - D. 2D

7. There are how many counter groups:
   - A. 20
   - B. 80
   - C. 16
   - D. 3

8. There are how many comparing magnets:
   - A. 20
   - B. 16
   - C. 2
   - D. 80

9. Which of the following statements is true.
   - A. Third reading can be wired to the typebars to list information.
   - B. Third reading can be wired to counter entry to add information.
   - C. Third reading can be wired to the comparing magnets for comparing.
   - D. All the above are true.

10. How many asterisk symbol exit hubs are there –
    - A. 8
    - B. 5
    - C. 4
    - D. 6

Answer the following questions true or false. If True mark an X in Box A; if False, mark an X in Box B.

11. Bus hubs are common hubs.

12. It is impossible to compare a field that is also being printed.

13. Comparing exits emit impulses when their comparison is equal.

14. Asterisk symbols are in every odd-numbered numeric typebars.

15. The hammersplit levers for every typebar printing an asterisk must be raised.

16. Totals must be printed in the numeric typebars.

17. Minor, intermediate and major totals are called automatic totals.

18. The unequal impulse from comparing exit is normally wired to counter total hubs to cause counters to clear.

19. Program total exit hubs are activated when their corresponding program start hubs are impulsed.

20. Information which enters counter entry is available from counter exit only if that counters plus hub had been impulsed from card cycles.

I.B.M. DATA PROCESSING AND COMPUTER PROGRAMMING

LESSON #15

TABLE OF CONTENTS

15. 1) Group Printing

15. 2) Subtraction

15. 3) Use of Pilot Selectors

Glossary

Examination

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15.1 GROUP PRINTING

The types of exercises and problems discussed so far in the 402 portion of this training program have all been of the "detail printed" nature – every card passing through the machine is printed. Figure 1 illustrates a typical detail printed report with totals by Vendor Number.

There are many situations where we are interested only in obtaining totals for each control group – and we are not interested in having all the detail which is contained in the cards printed on the report. In these situations we prepare what we call a group printed or "tabulated" report. Figure 2 presents our "Purchase Analysis by Vendor" in tabulated form.

Note that in a tabulated report, we get totals for each control group and also information which identifies or describes the total. This information is called "indicative information." In this case, vendor number and vendor name are the indicative information.

PURCHASE ANALYSIS BY VENDOR

Vendor No.	Vendor Name	Invoice Amount	Discount	Amount To Pay
1179	ABBOT BRASS	98 13	1 96	96 17
1179	ABBOT BRASS	25 00	50	24 50
		123 13 *	2 46 *	120 67 *
1180	ABRAMS COAL	277 35	8 31	269 04
1180	ABRAMS COAL	300 00	10 50	289 50
		577 35 *	18 81 *	558 54 *
1181	ACE INS CO	18 50		18 50
1181	ACE INS CO	118 02		118 02
		136 52 *	*	136 52 *
1281	AMER STEEL	82 35	1 65	80 70
1281	AMER STEEL	182 34	3 62	178 72
1281	AMER STEEL	27 25	55	26 70
		291 94 *	5 82 *	286 12 *
2179	APAL LUM CO	224 00	4 48	219 52
2179	APAL LUM CO	143 30	2 87	140 43
		367 30 *	7 35 *	359 95 *
3076	BARR MACH	3015 27	150 77	2864 50
		3015 27 *	150 77 *	2864 50 *
6195	BR WILLIAMS	276 65		276 65
6195	BR WILLIAMS	104 51	3 15	101 36
6195	BR WILLIAMS	37 65	75	36 90
6195	BR WILLIAMS	310 52	6 21	304 31
		729 33 *	10 11 *	719 22 *
19285	COVTRY OIL	180 15	3 60	176 55
19285	COVTRY OIL	83 44	1 67	81 77
		263 59 *	5 27 *	258 32 *

Figure 1.

PURCHASE ANALYSIS BY VENDOR

Vendor No.	Vendor Name	Invoice Amount	Discount	Amount To Pay
1179	ABBOT BRASS	123 13	2 46	120 67
1180	ABRAMS COAL	577 35	18 81	558 54
1181	ACE INS CO	136 52		136 52
1281	AMER STEEL	291 94	5 82	286 12
2179	APAL LUM CO	367 30	7 35	359 95
3076	BARR MACH	3015 27	150 77	2864 50
6195	BR WILLIAMS	729 33	10 11	719 22
19285	COVTRY OIL	263 59	5 27	258 32
29521	EL TRUST CO	205 50		205 50
36512	HASK SUPP	1334 34	25 73	1308 61

Figure 2.

How does a detail printed report differ from a group printed report? In a detail printed report every card prints as well as all totals. In a group printed report, only the first card of each control group prints, and then its totals print along side of the indicative information.

Figure 3 is a diagram of the control panel required to prepare our detail printed report as shown in Figure 1. We can change this diagram to give us a group printed report.

1. When group printing, we do not want every card to print. Therefore, we remove the wire from All Cycles to List. Now the machine will automatically print a line for the first card of each control group as well as our totals.
2. When the 402 recognizes a group print situation, it causes the first card of each control group to print. This is perfectly all right for our indicative information, but it creates a problem in all of our amount fields. For example, the invoice amount in our first card is 9813. This will print as the first card passes through the machine. However, the total for vendor 1179 will print on the same line as the indicative information for this vendor. This total (12313) will print right over the amount (9813) making it impossible to read either amount. Obviously, if we are only interested in totals, we do not want any of the detail amounts to print. How then, do we prevent the detail amount from printing for the first card of each control group?

We know that when information enters counter entry and the counter is impulsed to add, that the information is available from the counter exit hubs. There is an internal connection between counter entry and counter exit at this time. Well, we still want information to enter the counter since we do want to add. However, we want to prevent this information from printing. In other words, we want to break the internal connection which is established between counter entry and counter exit.

For each counter group there is a pair of common hubs called counter exit suppression, (Y-Z, 51-66). When counter exit suppression receives an impulse, the internal connection between counter entry and counter exit is broken. At this time, information which

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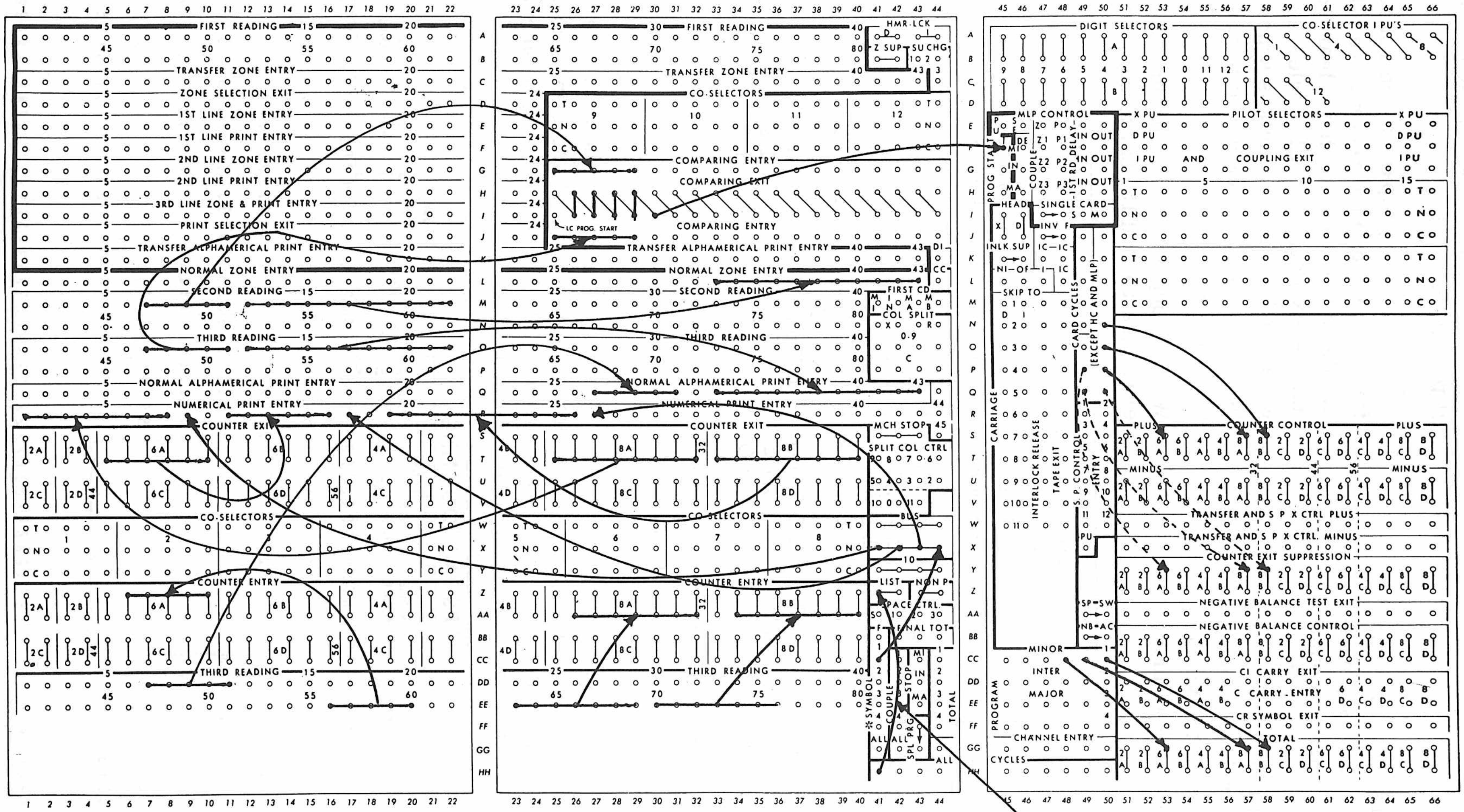


REMOVE ALL CYCLES TO LIST WIRE WHEN GROUP PRINTING

FORM LAYOUT

Report Headings	PURCHASE ANALYSIS		BY VENDOR		
Field Headings	VENDOR #	VENDOR NAME	INV. AMT.	DISCOUNT	AMT. TO PAY
Card Columns	7-11	12-22	63-69 *	56-60 *	70-76 *
Type Bars					
Short Hmrlck Levers					
Long Hmrlck Levers					
Hammersplit Levers			✓✓	✓✓	✓✓
Demountable Type					
Class of Total					

Figure 3.

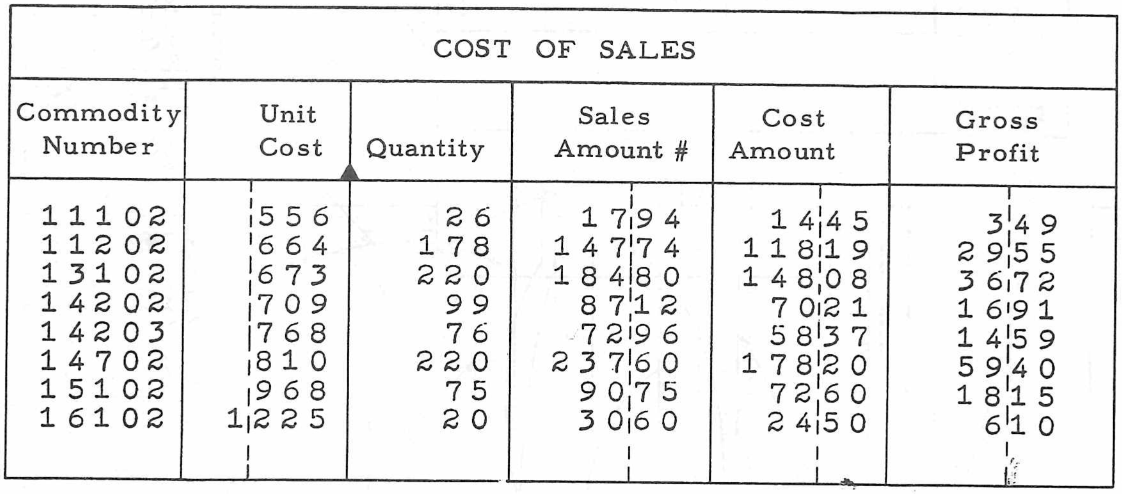
enters counter entry will add but it will not print.

3. For each of our counters, we wire from card cycles to counter exit suppression. Information entering the counters will add but it will not print. Since card cycles does not emit at total time, our totals will print. For the first card of each control group then, the vendor number and vendor name will print.

The machine spaces automatically after it prints the total.

4. In review – to prepare a control panel for a group printed report, we follow all the principles we have learned to date – except: (a) all cycles is not wired to list; (b) all counters which are used have card cycles wired to counter exit suppression.

5. When group printing, the 402 will operate at a rate of 150 cards per minute.



COST OF SALES

Commodity Number	Unit Cost	Quantity	Sales Amount #	Cost Amount	Gross Profit
11102	556	26	1794	1445	349
11202	664	178	14774	11819	2955
13102	673	220	18480	14808	3672
14202	709	99	8712	7021	1691
14203	768	76	7296	5837	1459
14702	810	220	23760	17820	5940
15102	968	75	9075	7260	1815
16102	1225	20	3060	2450	610

Figure 4.

SAMPLE PROBLEM: Figure 4 illustrates a group printed report and Figure 5 the card used to run the report. This report is a tabulation of cost of sales by commodity number. Commodity number (the control group) and unit cost are our indicative information. The balance of the report is to be accumulated in counters.

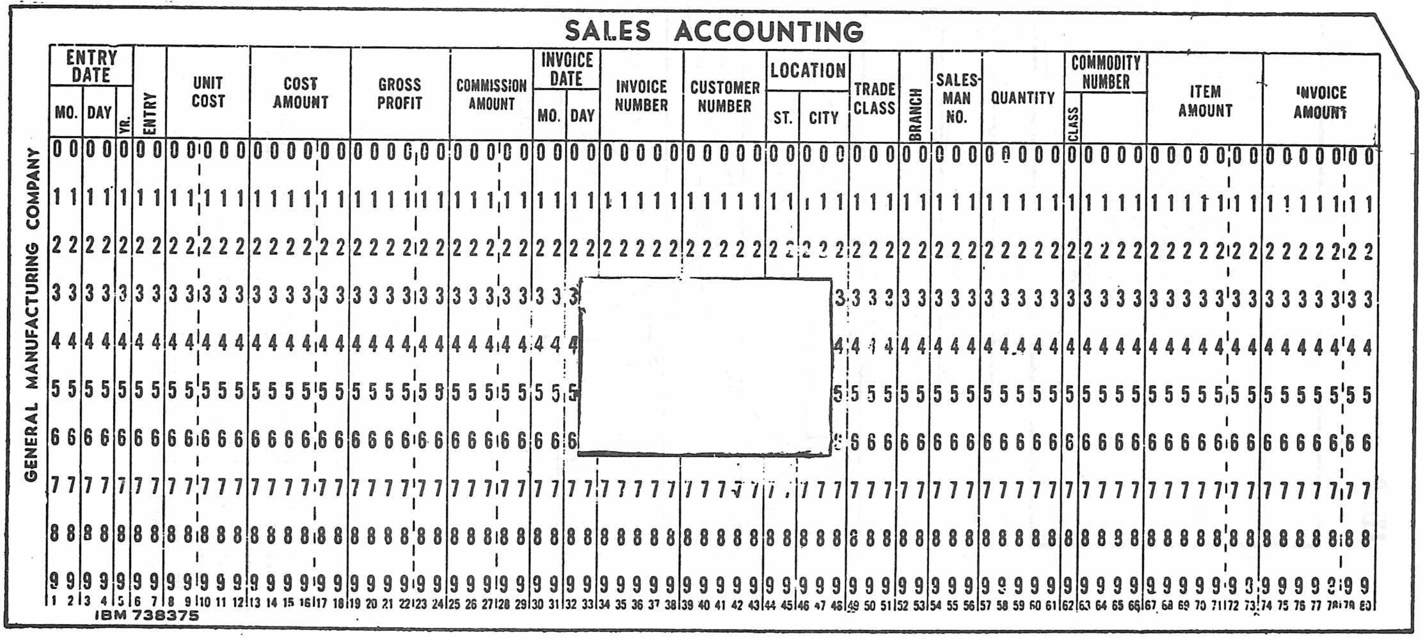


Figure 5.

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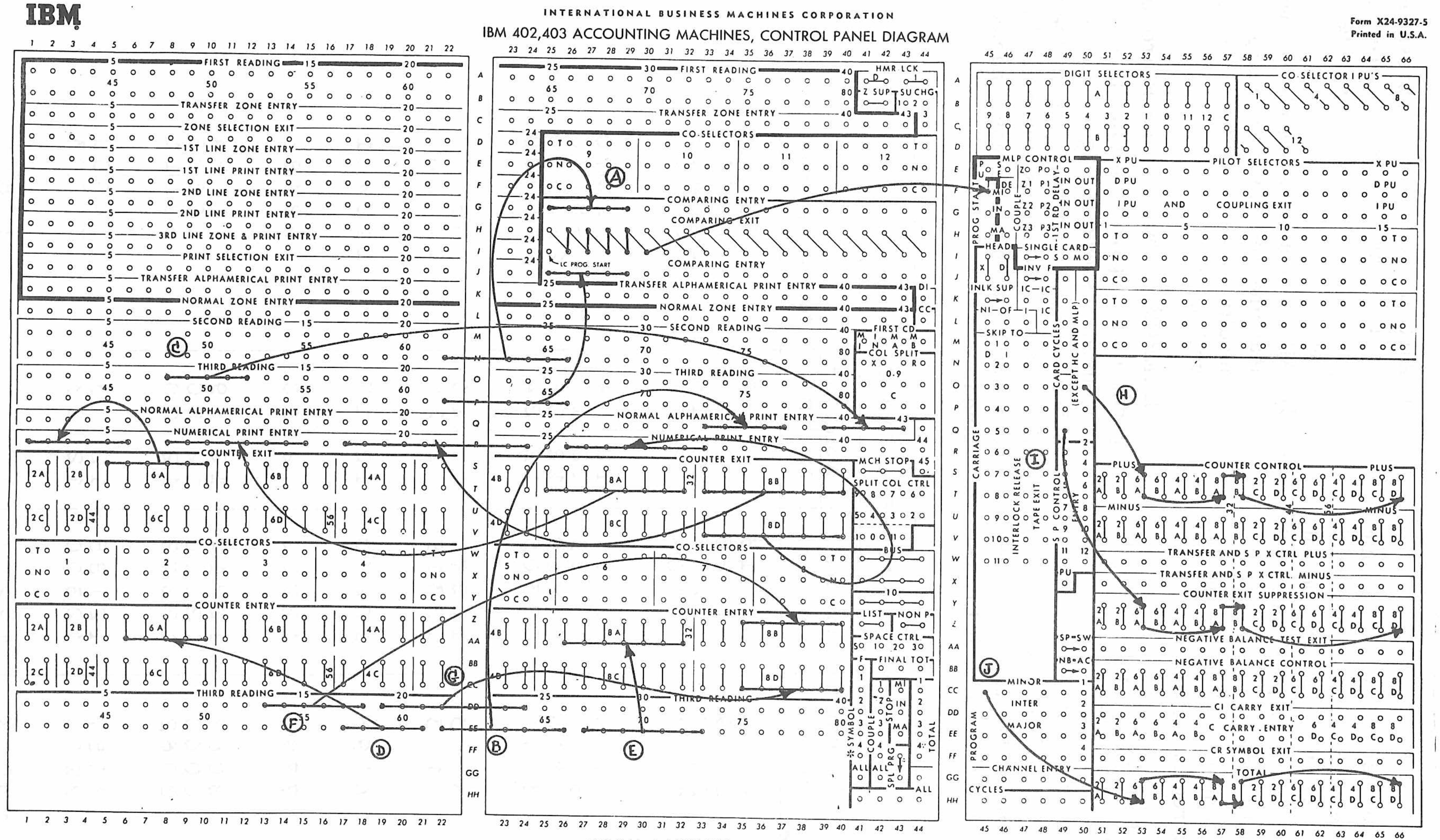


Figure 6.

FORM LAYOUT

Report Headings	Cost of		Sales			
Field Headings	Comm #	Unit Cost	Quan	Sales Amt.	Cost Amt.	Gross Prof
Card Columns	62-66	8-12	57-61	67-73	13-18	19-24
Type Bars						
Short Hmrlck Levers						
Long Hmrlck Levers						
Hammersplit Levers	✓		✓	✓	✓	✓
Demountable Type						
Class of Total						

FOLD TO HERE

Figure 6 is the control panel diagram required for this problem.

Notes on Figure 6:

A) Commodity number is wired to our comparing magnets from second and third reading as this is our control group. The unequal impulse is wired to minor program start.

B) Commodity number (which is to be printed) is wired to alpha. t. b. 33-37.

C) Unit cost (which is to be printed) is wired to alpha. t. b. 39-43.

D-G) Quantity, sales amount, cost amount and gross profit are wired to counters 6A, 8A, 8B, & 8D. The exits for these counters are wired to numeric t.b. 1-5, 8-15. 17-24, & 26-33

H) All four counters are wired to add each card.

I) All four counters are suppressed to prevent any information from reaching the typebars at the time the counter is adding.

J) All four counters are cleared when the machine recognizes a change in commodity number. At this time our totals will print.

EXERCISE: Diagram the control panel to produce the report shown in Figure 7. The card used is shown in Figure 8. A correct school solution will be found in the back of this lesson. Note that the control group is customer number & invoice number combined.

ACCOUNTS RECEIVABLE REGISTER

Customer Number	Invoice Number	Invoice Date		Invoice Amount
		Mo.	Day	
2179	12213	12	9	1038 77
2179	12220	12	10	620 34
2179	12254	12	16	2084 38
2179	12288	12	22	529 66
3076	92211	12	9	724 70
3076	92223	12	10	981 30
3076	92289	12	22	2245 50
3076	92305	12	24	1159 20
4123	12277	12	20	584 99
4123	12319	12	28	1191 65
6195	12260	12	17	1124 61
7792	12222	12	10	624 85
8062	12217	12	9	422 24
8062	12268	12	20	602 05
8062	12272	12	20	521 11
8257	12185	12	3	640 59
8257	12300	12	23	369 03
10723	12253	12	16	338 08

Figure 7.

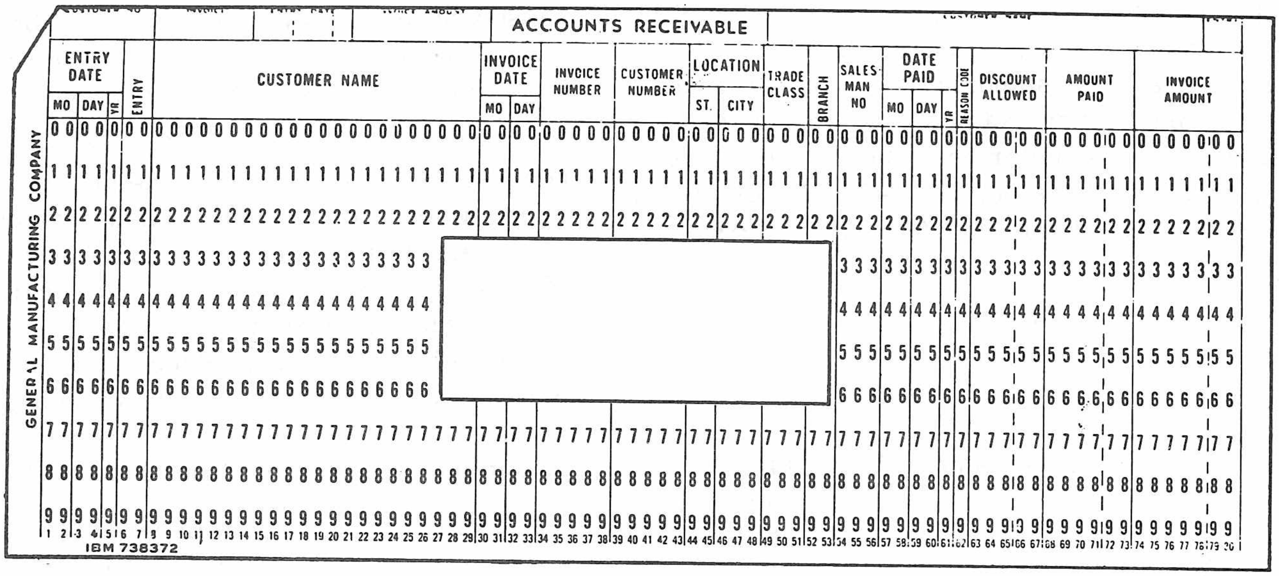


Figure 8.

15.2 SUBTRACTION

The 402 can perform two arithmetic functions – addition and subtraction. Where a problem involves addition only, the totals standing in our counters must always be positive. Should the problem involve both addition and subtraction, the result could be positive and it could also be negative. Assume that we were using an 8-position counter for both addition and subtraction. If at the time the counter were cleared and it contained the positive number 00657863, it would print as 657863 (the hammersplit levers would prevent the high-order zeroes from printing). However, should the counter contain the negative number 00657863, it would print as the "nines complement" of this number or as 99342136. The nines complement of a number is that number subtracted from a string of nines.

$$\begin{array}{r} 99999999 \\ \underline{-00657863} \\ 99342136 \end{array}$$

Should a counter be negative at the time it is ready to clear, we would want to do two things:

1. We would want to convert the nines complement which is standing in the counter to a positive figure: we do this by wiring the counter's "Negative Balance Test Exit" hub (AA, 51-66) to its "Negative Balance Control" hub, (BB-CC, 51-66). Should the total standing in the counter be negative, the 402 will execute a "conversion" cycle and convert the nines complement to a true positive figure.

2. After the conversion cycle, the total standing in the counter appears as a positive (true) total. We would want to identify this total as a negative total (since this is what it actually is). When a counter is converted, its "CR Symbol Exit" hub (FF, 51-66) emits an impulse. This impulse is normally wired to the even-numbered numeric typebar closest to the total. Every even-numbered numeric typebar contains the symbol "CR". We know that every odd-numbered numeric typebar contains the symbol "*".

Note here that we convert nines complement figures because they are difficult to read. We are accustomed to reading true figures.

When does a counter subtract? A counter subtracts when (1) information enters the counter, and (2) the counter's "minus" hubs, (U-V, 51-66) receive an impulse to subtract. Whenever a counter subtracts, it does so using the nines complement method. A characteristic of this method is that it always leaves the total standing in the counter as "one short." For example, assume that the contents of a counter are 006789+ and it is told to subtract the number 345. It actually adds the nines complement of 345 or 999654. What happens:

$$\begin{array}{r} 006789 \\ \underline{+999654} \\ (1)\ 006443 \end{array}$$

The actual answer should be 006444 (subtract 345 from 006789 yourself). Note that there is a carry of "1" which is exactly the digit we need to correct our total. This "1" is added to the units position of our counter internally by wiring the "CI" hub (DD, 51-66) or the counter to its "C" hub, (EE, 51-66).

Let us state the rules for wiring counters which are being used to subtract as well as add:

1. To convert the nines complement total to a true total, wire the Negative Balance Test Exit hub of the counter to its Negative Balance Control.
2. Identify the total by wiring the CR Symbol Exit hub to an even-numbered numeric typebar.
3. Wire the CI Carry Exit hub of the counter to its C Entry Hub.
4. The counter subtracts when information enters the counter and counter "minus" is impulsed.

A practical problem involving subtraction would be one where certain cards only are subtracted from a counter and other cards are added in that same counter. Before we can develop a problem of this nature, we should first discuss the topic of 402 selectors which permit us to distinguish between types of cards.

15.3 USE OF PILOT SELECTORS

There are three types of selectors in the 402: (1) pilot selectors, which will be discussed here; (2) digit selectors, to be discussed in the next lesson; and (3) Co-selectors, to be discussed in a later lesson.

Pilot selectors (E-M, 51-66) are so named because as you will see later one of their uses is to "pilot," or control, other selectors. There are 16 pilot selectors in the 402, each of which has two positions. If you recall, the 552 Interpreter had two selectors, each of which had ten positions. Each of our 402 selectors has three types of pickup hubs; (remember, the 552 selector had one type of pickup hub (X-pickup). The three types are:

1. XPU - (X Pick Up) - these hubs will accept an X or 12 impulse ONLY and cause the selector (both positions) to transfer on the following machine cycle. We know that the most common method of distinguishing between types of cards is to use an X control punch. This X control punch is normally read from a card when that card is passing second reading and when wired to the XPU hub of a pilot selector will cause that pilot selector to transfer when that card is passing third reading(this is the next card cycle).
2. DPU - (Digit Pick Up) - each pilot selector has a DPU hub. This hub will accept any impulse and cause the selector to transfer one machine cycle later.
3. IPU - (Immediate Pick Up) - this hub will accept any impulse and cause the selector to transfer immediately(for the balance of that same machine cycle.)

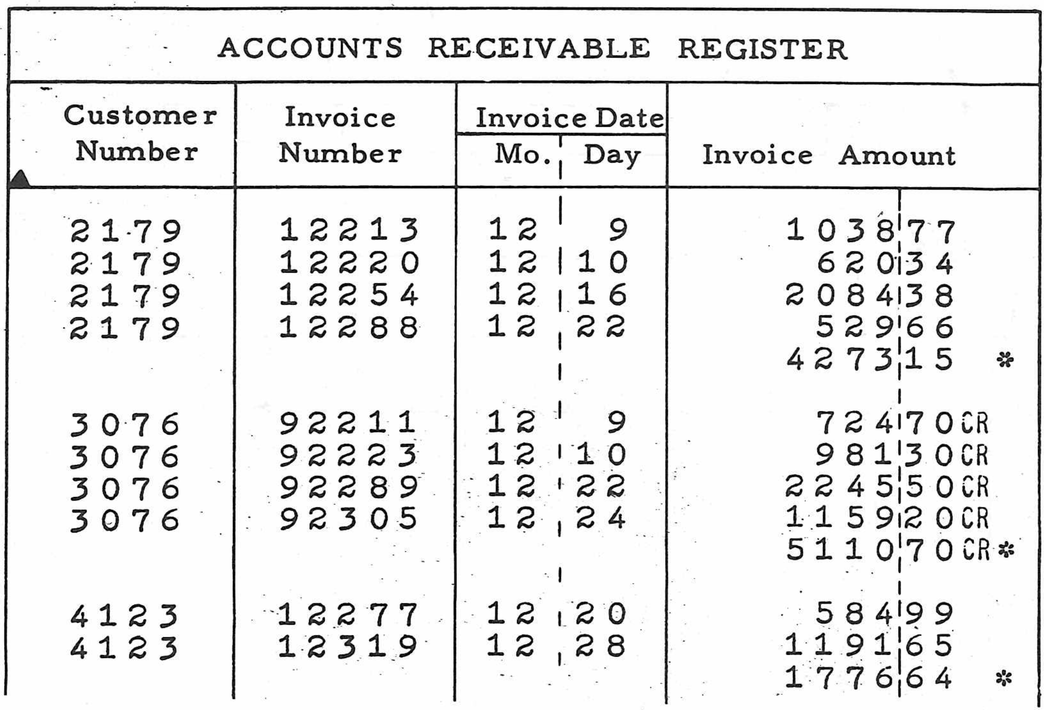
Let us review our rules of selection:

1. When a selector is normal, there is an internal connection between the selector's Common (C) and Normal (N) hubs.
2. When a selector is transferred, there is an internal connection between the selector's Common (C) and Transfered (T) hubs.
3. The selector drops out (returns to a normal condition) after every machine cycle.

SAMPLE PROBLEM: Let us look at a problem which will incorporate a subtraction process together with the use of pilot selectors.

We are going to prepare a detail printed report called an Accounts Receivable Register. Figure 9 illustrates the report and Figure 10 the cards used.

This report contains cards representing sales and returns. Returns are distinguished from sales by an "X" punch in c.c. 78. Sales are added, returns are subtracted.



ACCOUNTS RECEIVABLE REGISTER

Customer Number	Invoice Number	Invoice Date Mo.	Invoice Date Day	Invoice Amount
2179	12213	12	9	1038 77
2179	12220	12	10	620 34
2179	12254	12	16	2084 38
2179	12288	12	22	529 66
				4273 15 *
3076	92211	12	9	724 70 CR
3076	92223	12	10	981 30 CR
3076	92289	12	22	2245 50 CR
3076	92305	12	24	1159 20 CR
				5110 70 CR *
4123	12277	12	20	584 99
4123	12319	12	28	1191 65
				1776 64 *

Figure 9.

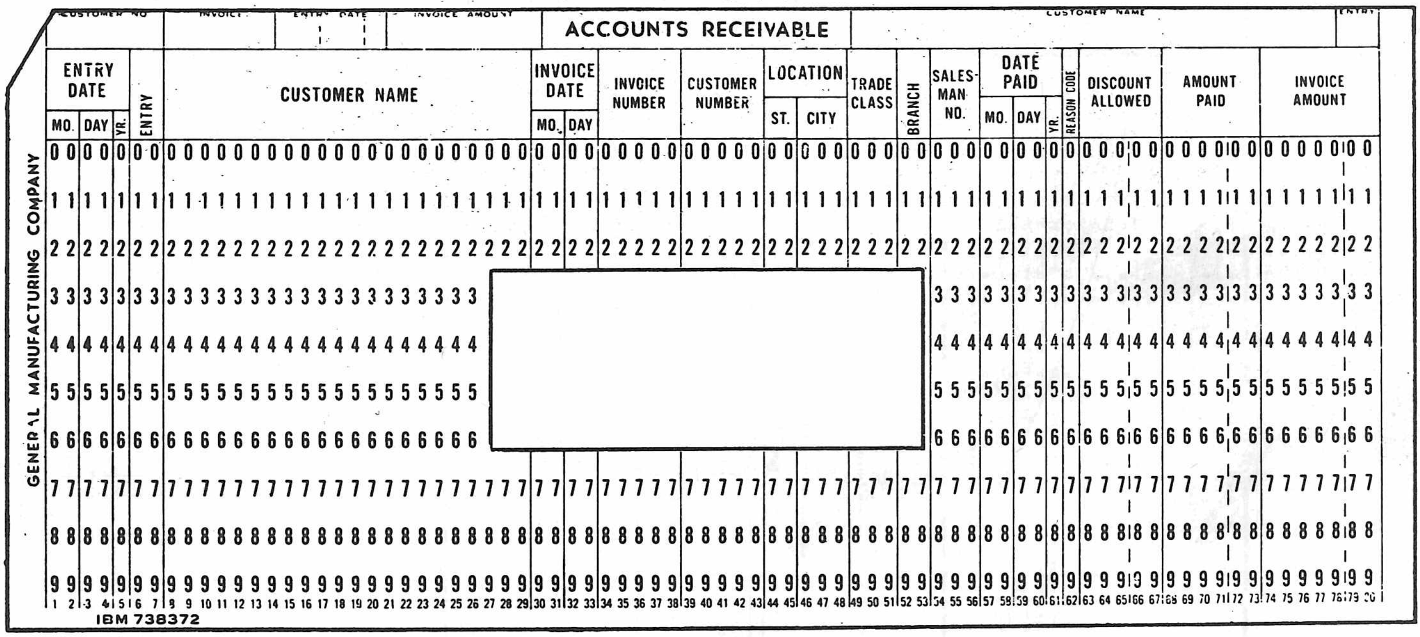


Figure 10.

Figure 11 represents the solution to this problem.

Notes on Figure 11:

A) Customer number is wired to print.

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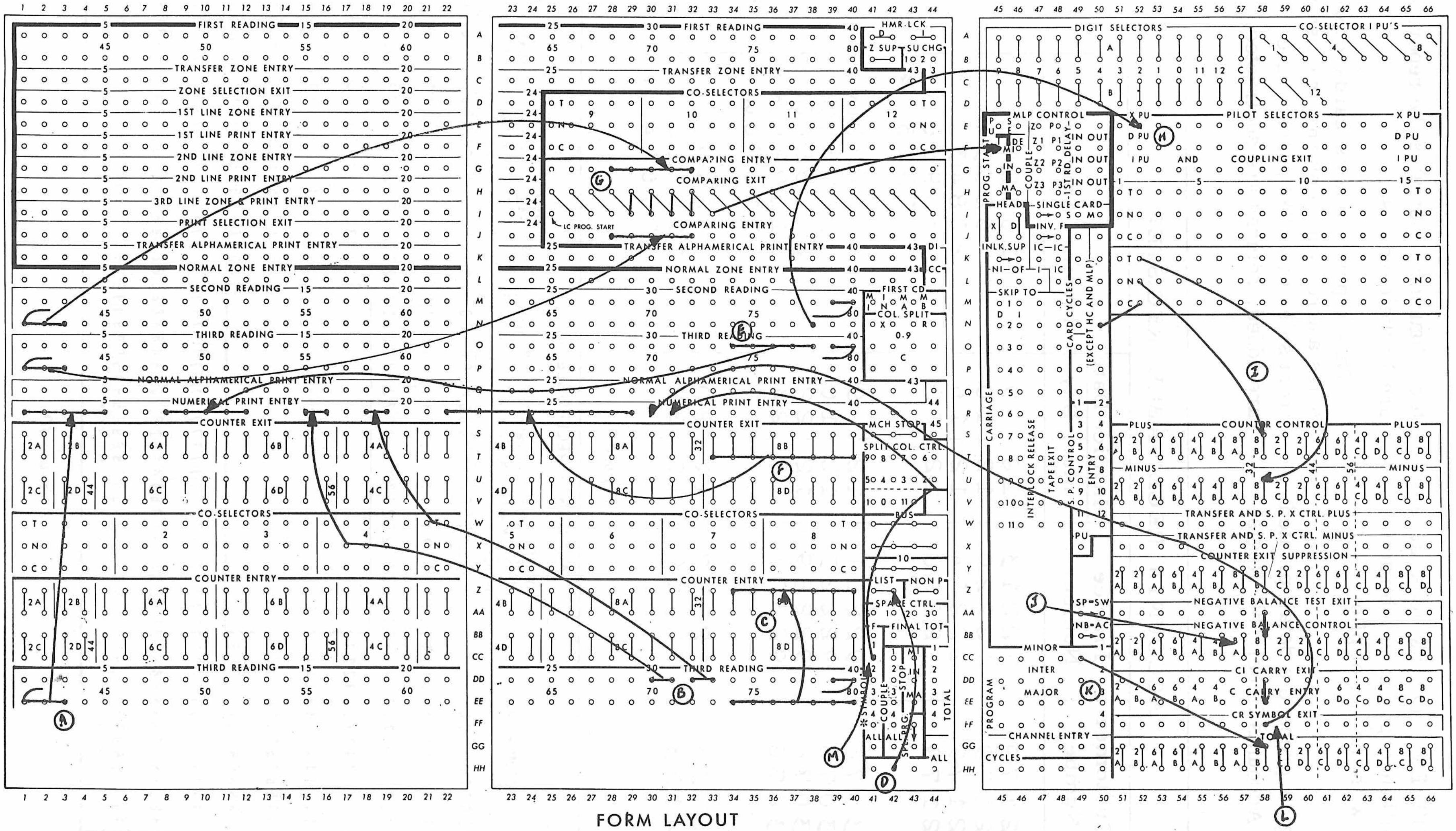


FORM LAYOUT

Report Headings	Accounts Rec. Register					
Field Headings	Cust. No	Inv. No.	Mo	Day	Inv. Amt.	CR #
Card Columns	39-43	34-38	30-1	32-3	74-80	
Type Bars						
Short Hmrlck Levers						
Long Hmrlck Levers						
Hammersplit Levers	✓	✓	✓	✓	✓✓	(N)
Demountable Type						
Class of Total						

(7-61:20M-S)

Figure 11.

B) Month and day are wired to print.

C) Invoice amount enters counter 8B.

D) All cycles is wired to list as this is a detail printed report.

E) Invoice number is wired to print.

F) Amounts being added or subtracted as well as all totals will come out of counter exit.

G) Customer number wired for program control. The unequal impulse is wired to minor program start.

H) Card column 78 from second reading is wired to the XPU hub of pilot selector 2. Should a card contain an X78 (a return card) this selector will transfer when the X78 card is passing under third reading.

I) Card cycles is wired to the common hub of pilot selector 2. For all sales cards (NX 78) this selector will be normal and the card cycles impulse will enter counter plus. For all return cards, this selector will be transferred and the card cycles impulse will enter counter minus.

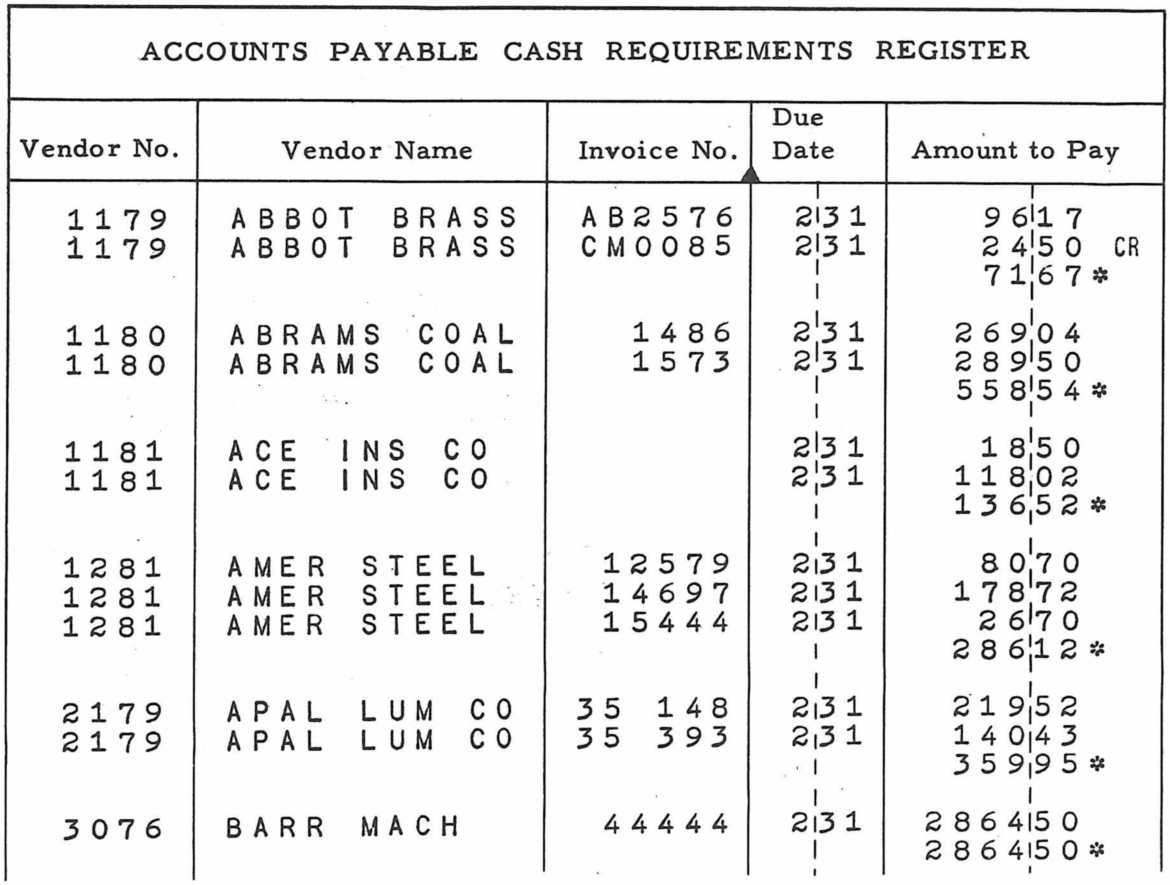
J) Negative balance test exit is wired to negative balance control to convert any minus totals to a true rather than a complement amount. Also, CI of counter 8B is wired to the C hub of 8B to give us the required carry for proper subtraction results.

K) Counter 8B is cleared with a minor program exit.

L) The CR symbol exit hub emits an impulse (1) every time the counter subtracts; (2) when the counter is converted at total time. This impulse when wired to an even-numbered numeric typebar will cause the symbol CR to print.

M) As asterisk (*) is printed in numeric t. b. 31 to identify the total line.

N) Hammersplit levers are raised for all typebars that print CR or * symbols.



ACCOUNTS PAYABLE CASH REQUIREMENTS REGISTER

Vendor No.	Vendor Name	Invoice No.	Due Date	Amount to Pay
1179	ABBOT BRASS	AB2576	2 31	96 17
1179	ABBOT BRASS	CM0085	2 31	24 50 CR
				71 67 *
1180	ABRAMS COAL	1486	2 31	269 04
1180	ABRAMS COAL	1573	2 31	289 50
				558 54 *
1181	ACE INS CO		2 31	18 50
1181	ACE INS CO		2 31	118 02
				136 52 *
1281	AMER STEEL	12579	2 31	80 70
1281	AMER STEEL	14697	2 31	178 72
1281	AMER STEEL	15444	2 31	26 70
				286 12 *
2179	APAL LUM CO	35 148	2 31	219 52
2179	APAL LUM CO	35 393	2 31	140 43
				359 95 *
3076	BARR MACH	44444	2 31	2864 50
				2864 50 *

Figure 12.

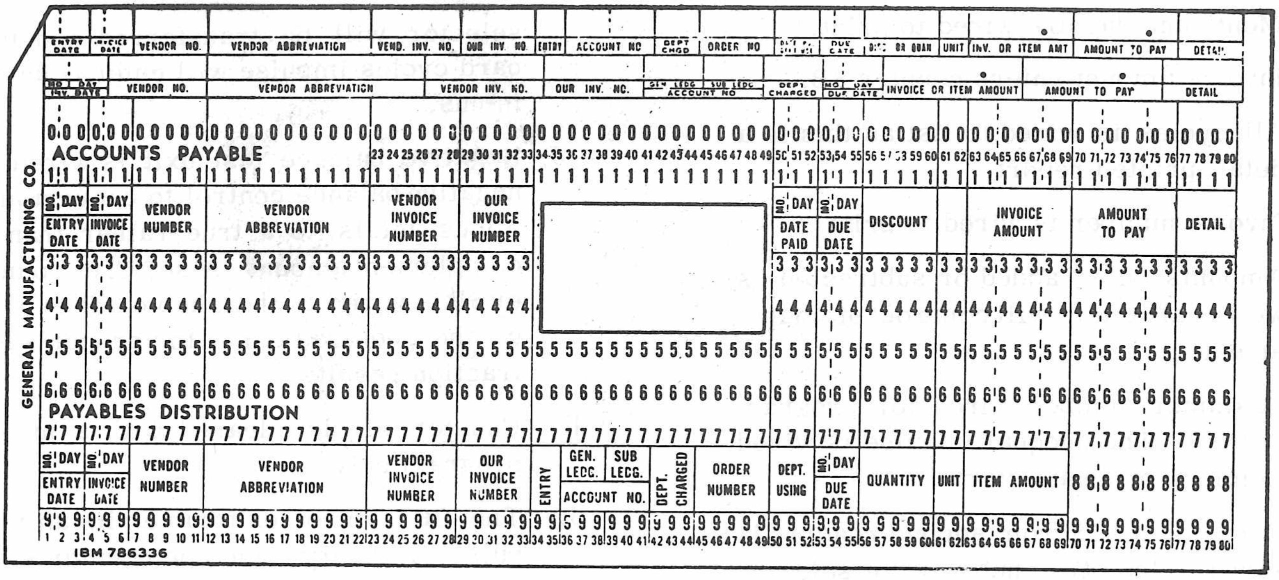


Figure 13.

EXERCISE: Diagram the control panel required to produce the report shown in Figure 12. The card used is shown in Figure 13. A correct school solution will be found in the back of this lesson. Credit cards have an X punch in c.c. 63. Use counter 8C to accumulate your amount field. The invoice number field shown is the vendor's invoice number, c.c. 23-28. This is a detail printed report.

NOTE: When a pilot selector receives an impulse into its X-pickup hub, it will transfer at the beginning of the next machine cycle and stay in the transferred state for one card cycle. This means that if a total cycle(s) intervenes between the time the selector receives the pickup impulse and the next card cycle, the selector will be transferred during the intervening total cycle(s) and for the following card cycle.

GLOSSARY

C Carry Entry Hub – This hub is connected to the CI Carry Exit hub of its counter whenever that counter is used for subtraction.

CI Carry Exit Hub – This hub is normally wired to the C Carry Entry hub of its counter whenever that counter is used in subtraction. It emits a "1" which is added to the units position of the counter.

Conversion Cycle – When a counter is impulsed to clear and it contains a negative (complement) total, the 402 takes a cycle to convert this complement total to a true total.

Counter Exit Suppression – Whenever these hubs receive an impulse, they prevent any information from coming out of their corresponding counter exit hubs.

CR Symbol – Both of these letters are contained in every even-numbered numeric typebar. They are usually printed to indicate that the total they correspond to is a negative (minus) total.

DPU Hub – Each pilot selector has a DPU hub. This hub will accept any impulse and transfer the selector for the next card cycle.

Group Printing – The type of report where totals only are printed for each control group along with selected pieces of indicative information.

IPU Hub – This selector pick-up hub will accept any impulse and transfer the selector immediately for the balance of that card cycle.

Indicative Information – This type of data is printed alongside of totals in a group-printed report to identify each total.

Minus Hub – Each counter has a set of two common hubs which, when impulsed, cause the counter to subtract the information entering it.

Negative Balance Control Hub – When this hub receives an impulse (from negative balance test exit) it converts the total standing in the counter from a nines complement to a true total.

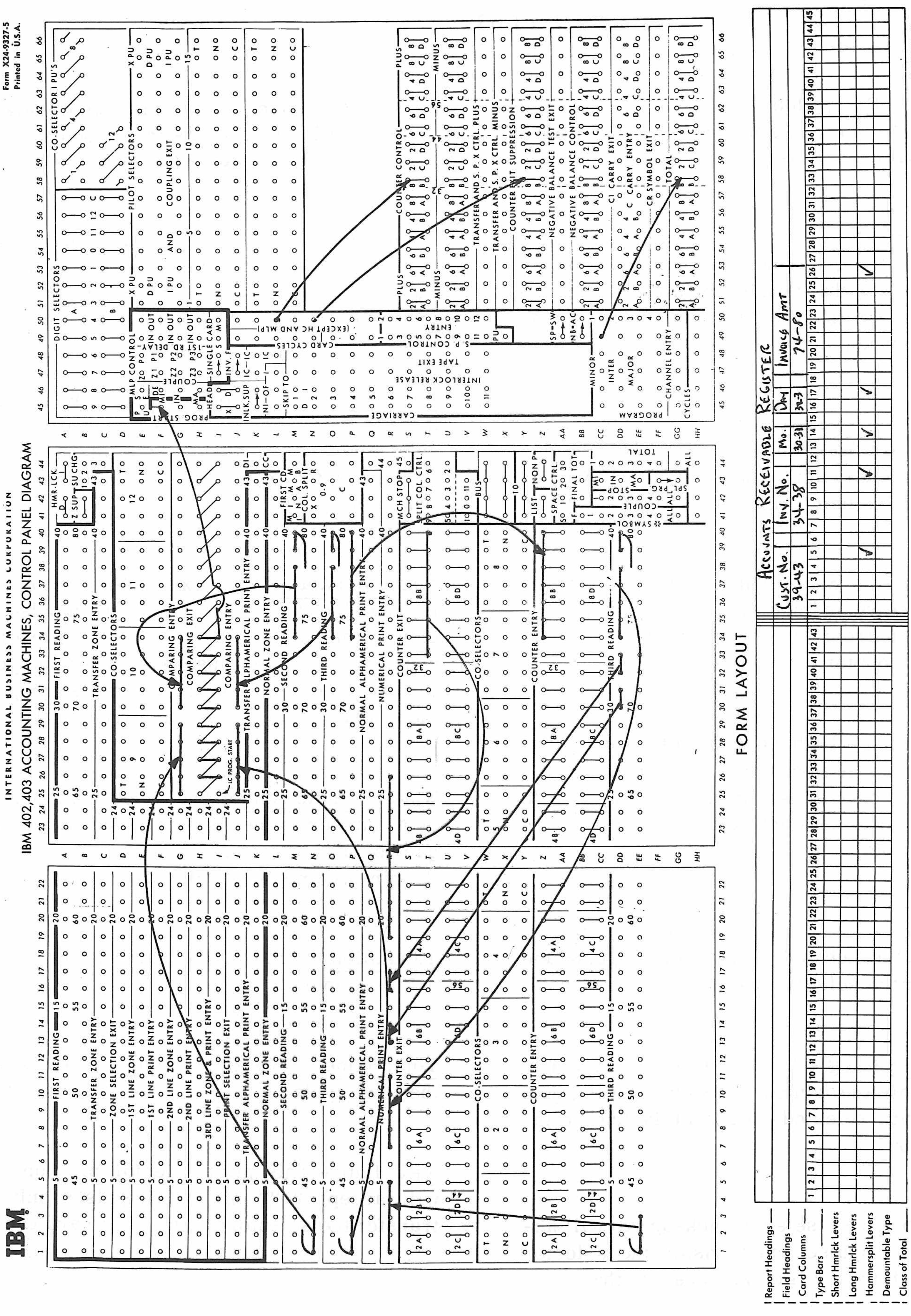
Negative Balance Test Exit – When a counter is negative and it receives an impulse to clear, this hub emits an impulse before the counter clears to cause a conversion cycle to take place and convert the nines complement total in the counter to a true total.

Nines Complement – The nines complement of a number is the result of subtracting that number from a string of nines. For example, the nines complement of 67548 is 32451.

Tabulation – This is the same as a group-printed report.

Total Time – The time required to execute the total cycle.

XPU Hub – This pilot selector pick-up hub will accept "12" or "x" impulses only to transfer the selector for the next card cycle.



Solution to exercise 1.

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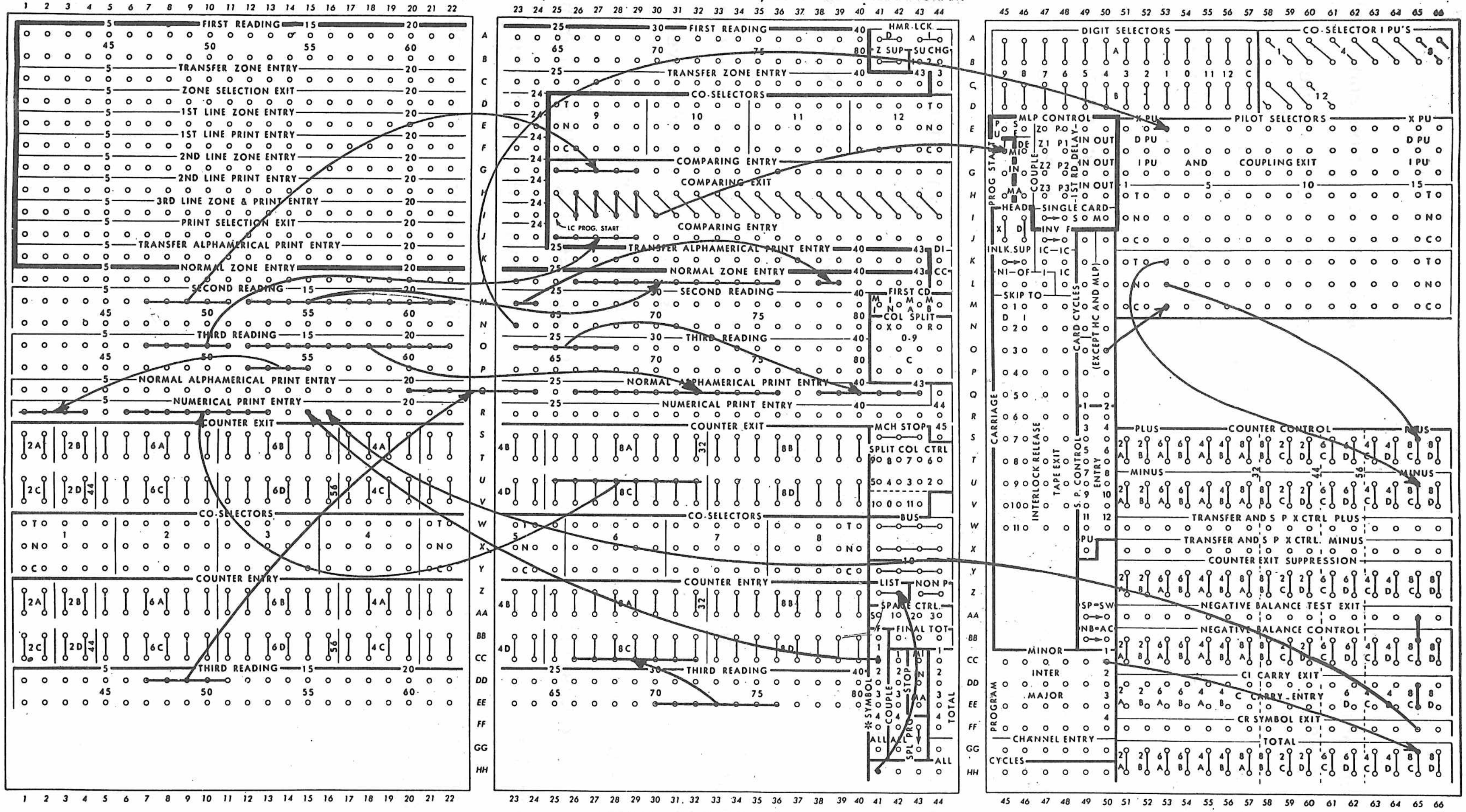
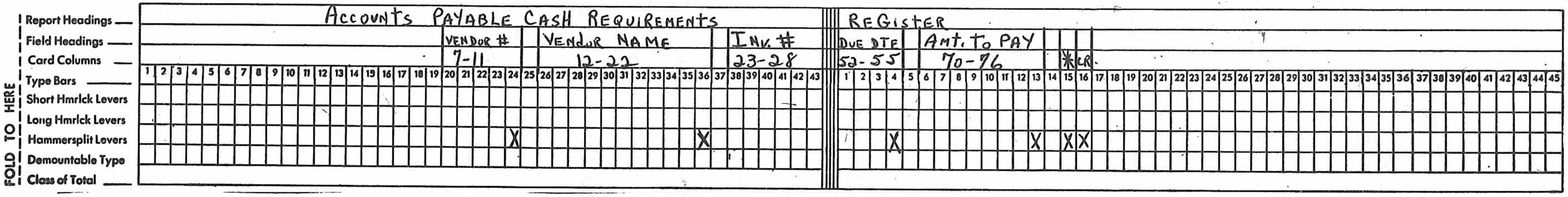


FORM LAYOUT



Report Headings — ACCOUNTS PAYABLE CASH REQUIREMENTS REGISTER

Field Headings — VENDOR # | VENDOR NAME | INV. # | DUE DTE | AMT. TO PAY | * CR

Card Columns — 7-11 | 12-22 | 23-28 | 52-55 | 70-76

Type Bars — 1–43 | 1–45

Short Hmrlck Levers —

Long Hmrlck Levers —

Hammersplit Levers — X (24) X (36) | X (4) X (13) X (15) X (16)

Demountable Type —

Class of Total —

FOLD TO HERE

Solution to exercise 2.

EXAMINATION – LESSON 15

Refer to Figure 14 and answer the following questions True or False. If True, mark an X in Box A; if False, mark an X in Box B.

1. c.c. 25-30 is our control group and is wired correctly.
2. The field in c.c. 32-40 is wired as if it were a numeric field.
3. This is a group printed report.
4. The fields in c.c. 25-30 and 32-40 would be called indicative information fields.
5. Counter 6A will add c.c. 47-50 from X 15 cards only.
6. Pilot selector 4 will be transferred at the time X 15 cards are passing the third reading brushes.
7. Counter 8A is wired to add c.c. 18-22 from X 15 cards only.
8. Detail information and totals will print from 8A numeric t.b. 15-22.
9. Counter 8B will add c.c. 75-80 from NX 15 cards and subtract c.c. 75-80 from X 15 cards.
10. Counter exit suppression of counter 8B should be wired from card cycles.
11. Counter 8B is wired correctly for subtraction.
12. The counters are being cleared correctly.
13. A CR symbol will print from numeric t.b. 32 whenever counter 8B is converted.
14. An asterisk will print in numeric t.b. 33 with the intermediate totals.
15. The proper hammersplit levers are indicated.

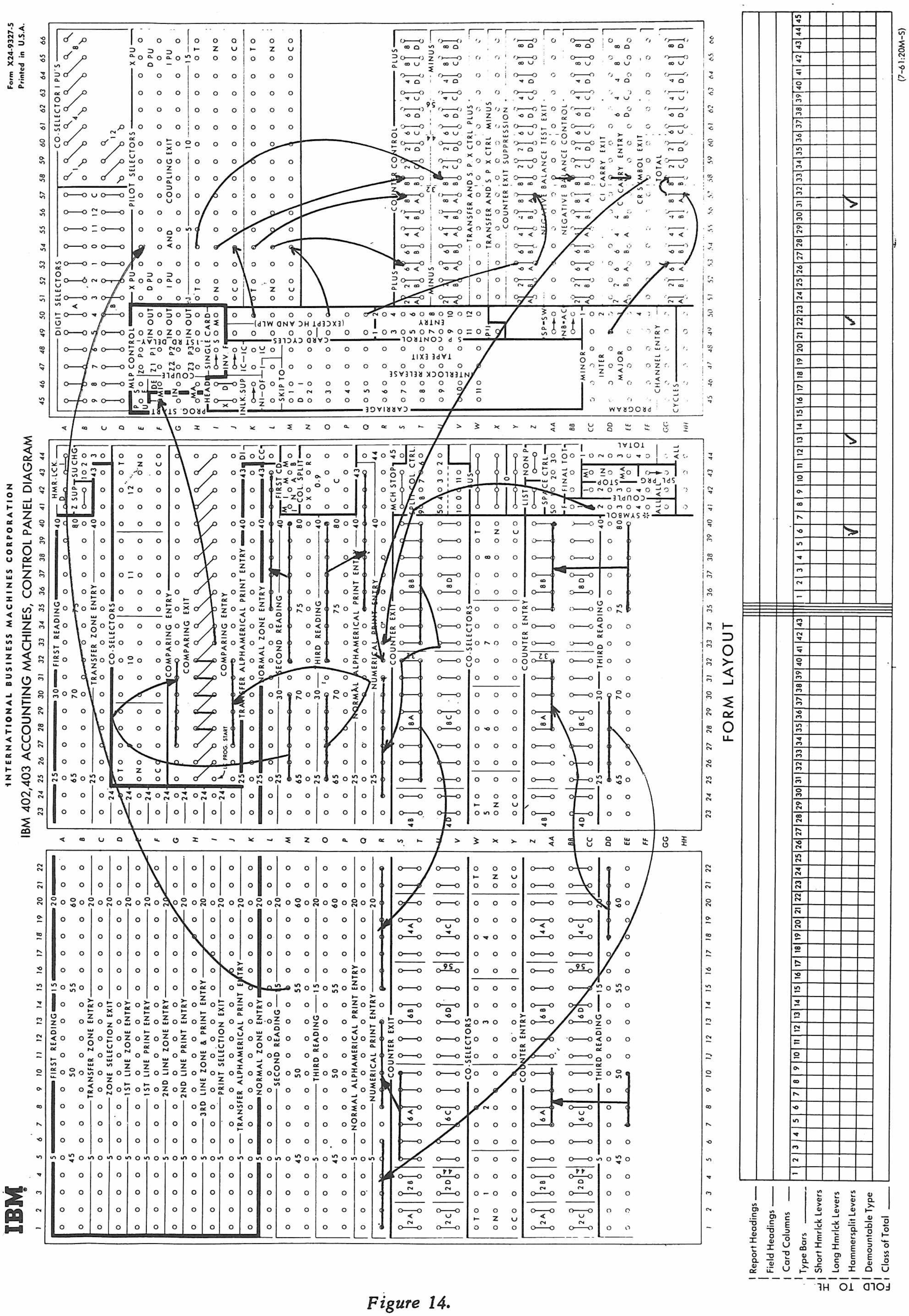

IBM
INTERNATIONAL BUSINESS MACHINES CORPORATION
IBM 402,403 ACCOUNTING MACHINES, CONTROL PANEL DIAGRAM
Form X24-9327-5
Printed in U.S.A.
FIRST READING
TRANSFER ZONE ENTRY
ZONE SELECTION EXIT
CO-SELECTORS
COMPARING ENTRY
COMPARING EXIT
TRANSFER ALPHAMERICAL PRINT ENTRY
NORMAL ZONE ENTRY
SECOND READING
THIRD READING
NORMAL ALPHAMERICAL PRINT ENTRY
NUMERICAL PRINT ENTRY
COUNTER EXIT
COUNTER ENTRY
DIGIT SELECTORS
PILOT SELECTORS
CO-SELECTOR I PU'S
COUPLING EXIT
COUNTER CONTROL
PLUS
MINUS
TRANSFER AND S P X CTRL PLUS
TRANSFER AND S P X CTRL MINUS
COUNTER EXIT SUPPRESSION
NEGATIVE BALANCE TEST EXIT
NEGATIVE BALANCE CONTROL
CI CARRY EXIT
CARRY ENTRY
CR SYMBOL EXIT
TOTAL
PROGRAM
CARRIAGE
CARD CYCLES
TAPE EXIT
INTERLOCK RELEASE
CHANNEL ENTRY
MINOR
INTER
MAJOR
FORM LAYOUT
Report Headings
Field Headings
Card Columns
Type Bars
Short Hmrlck Levers
Long Hmrlck Levers
Hammersplit Levers
Demountable Type
Class of Total
FOLD TO HL
(7-61:20M-S)

Figure 14.